Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

OCTOBER 1955

Four-Bar Linkages
as function generators

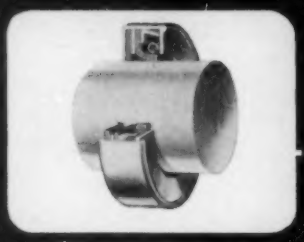
Hydraulic Piping

Design by Proportion

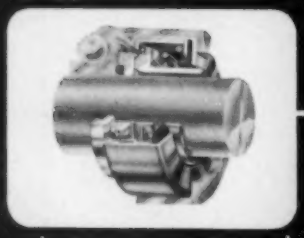
Sheet Metal Gages

Turbocharged 285-hp diesel tractor – see page 144

FOR PERFORMANCE PROTECTION

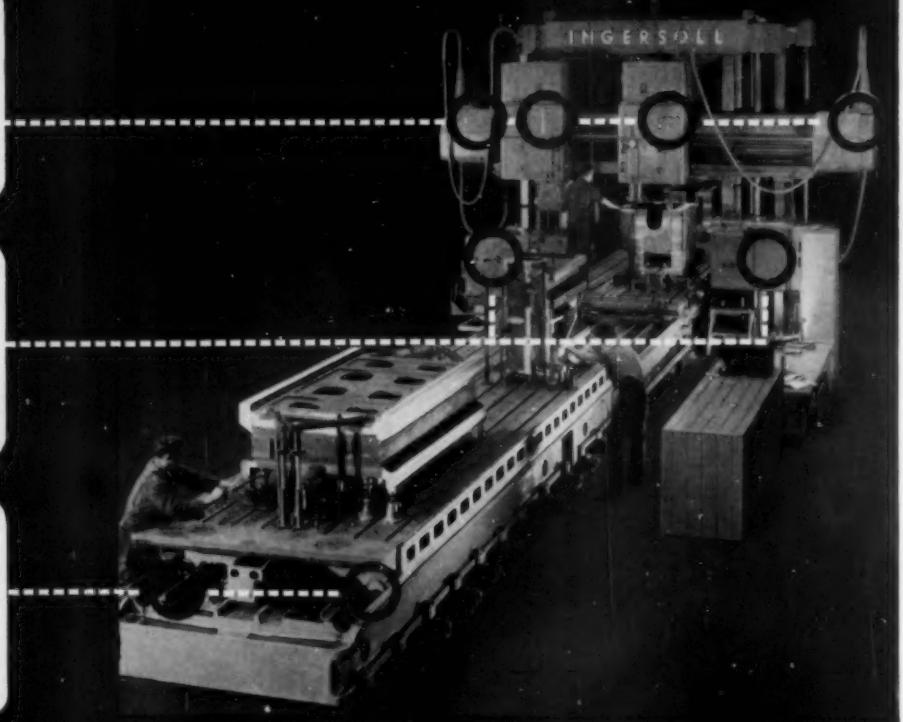


C/R SHAFT SEALS



C/R END FACE SEALS

C/R SIRVENE WAY WIPERS



Which seal is the best answer to your problem? C/R Engineers know. They've helped machine tool builders solve tough sealing problems—successfully—for years.

C/R SHAFT SEALS deliver outstanding sealing performance and service life on medium speed shafts, gear cases and drive mechanisms. They seal lubricants, exclude chips, coolants, abrasives—and require minimum radial and axial space.

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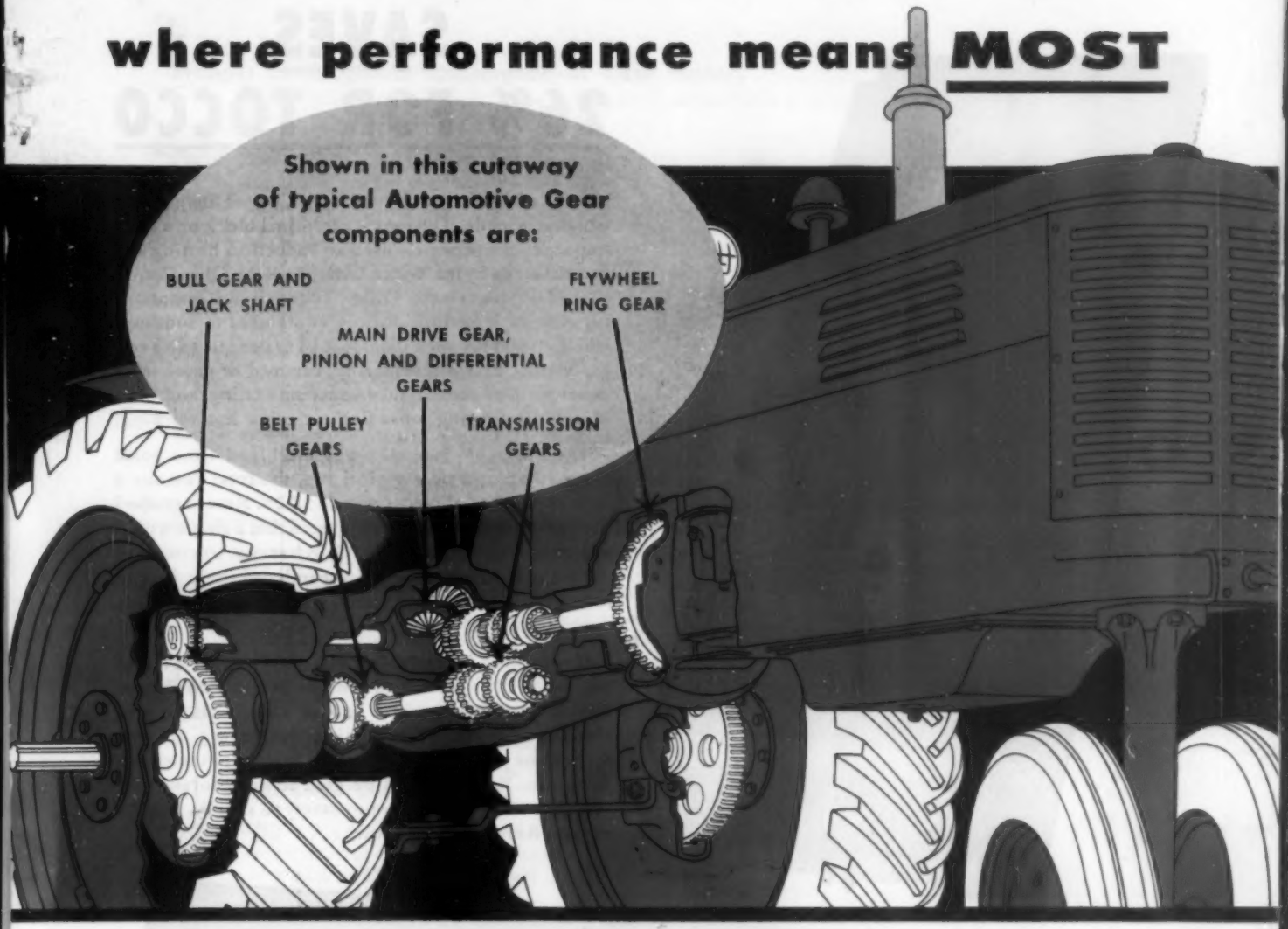
GEARS

where performance means MOST


Shown in this cutaway of typical Automotive Gear components are:
BULL GEAR AND JACK SHAFT
FLYWHEEL RING GEAR
MAIN DRIVE GEAR, PINION AND DIFFERENTIAL GEARS
BELT PULLEY GEARS
TRANSMISSION GEARS

When gears are used to transmit power there's no standard of comparison equal to on-the-job-performance. This is particularly true of farm machinery, where the dependability of gears is essential in maintaining the planting, cultivating and harvesting schedules.

Automotive Gears are used in a wide variety of the best-known, best-made farm machines. Their record is worth your inspection—no matter what your gear problem may be. This is particularly true if you are considering a source with the experience, the engineering service, and the facilities to serve as your "gear department." Just write or phone.

DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

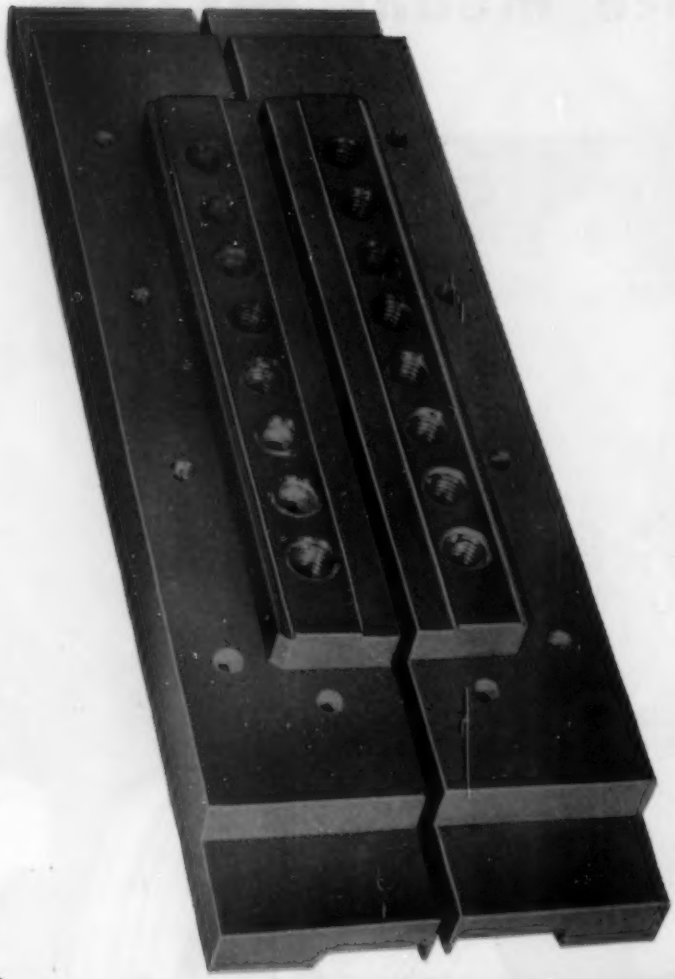
RICHMOND, INDIANA

REVERE

COPPER EXTRUDED SHAPE

SAVES

26% FOR TOCCO



Here is a "fishtail" and the Revere Copper Shape from which it is made. The part is a terminal block on a high frequency transformer, used in induction heating apparatus made by the Tocco Division of the Ohio Crankshaft Co., Cleveland, Ohio. Tocco is an important supplier of induction heating equipment to industry, which uses it for such diverse jobs as heat-treating and hardening, brazing, soldering, removal of gases from metal parts of vacuum tubes, vacuum casting, and heating before forging, upsetting, or other hot working.

The "fishtail" formerly was machined from solid copper bar, and on a typical run, the total cost for a certain number of pieces was $35,000. Revere studied the part with Tocco, and suggested that a shape would save money, even though the plain bar cost 10 cents less per pound. Actual experience produced these figures: total cost on the same number of fishtails, $25,700, a saving of $9,300, or 26.6%.

If your shop is machining plain rod or bar, it might pay you to consider the advantages of extruded shapes. Revere produces them in copper and its alloys, and aluminum alloys. Many design details can be preformed for you, provided they are parallel to the axis of extrusion. Revere would be glad to collaborate with you and see if shapes cannot save you money. See the nearest Revere Sales Office.

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Product Engineering

OCTOBER 1955 Vol. 26 No. 10 The McGraw-Hill Magazine of Design Engineering

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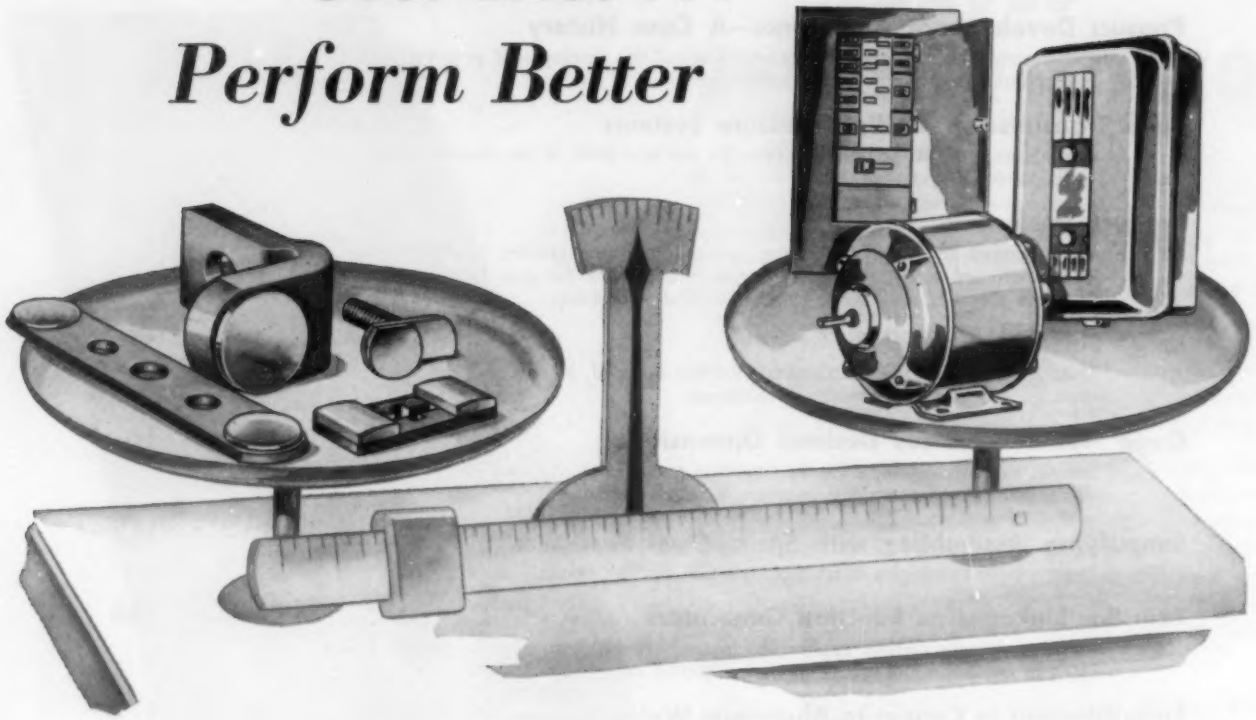
Contacts BALANCED to Their Job

Cost Less . . .
Perform Better



Balanced design pays dividends in the electrical contacts you use in your product. *Under-designing* of contacts can detract from the performance of your product and lead to troublesome, costly maintenance. *Over-designing* makes your contacts cost too much for the job they must do . . . and subtracts from your profits.

To engineer contacts to the specific requirements of your application, important environmental factors must be precisely weighed. Current and voltage to be interrupted . . . nature of the load circuit . . . anticipated life . . . number and frequency of make-and-break cycles . . . contact pressure and gap . . . ambient temperature and atmosphere . . . all demand careful consideration.

To be sure of getting contacts that meet all these requirements . . . at a cost that matches your application . . . bring your contact problems to Mallory. During more than thirty years of working with leading manufacturers of varied types of equipment, Mallory has developed not only an unequalled line of contact materials, but also a broad background of experience in contact design.

Our engineers will be glad to investigate your problem . . . to recommend the most effective Mallory contact material. Perhaps one of the many Mallory *standard* designs will meet your requirements. If not, Mallory engineers are well qualified to develop a *special* contact for your purpose. You can probably make additional savings, too, by having Mallory fabricate complete contact assemblies in our integrated manufacturing department.

Write today for a consultation with a Mallory engineer, and for a copy of our latest Contact Catalog.

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THIS MONTH'S COVER

Major problems faced and the design answers developed for new Caterpillar D9 tractor with its 286-hp turbocharged diesel engine are presented in the story starting on page 144. Power boosters for clutches and brakes, pushbutton starting, gears designed for infinite life, extensive use of filters, and new oil-type clutch, are important design features.

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Developments

To Watch

SUB-ZERO COLD WORKING OF STAINLESS STEEL . . . .

. . . . greatly increases the metal's strength and will make it perform better at ordinary temperatures. Still principally in the laboratory stage, there is almost no practical shop experience to study to see if such an operation (down to as low as –320 F) could be commercially economical. What is known about it to date is this, according to the Committee of Stainless Steel Producers American Iron & Steel Institute: Like other metals, an 18-8 chromium-nickel stainless steel, such as type 302, increases in tensile strength when it is chilled. In fact, it is nearly 2½ times as strong at –320 F than it is at room temperature.

What is not so well known is that when worked at sub-zero temperatures, stainless will attain a higher strength with less loss of ductility than if worked at room temperature. In tests, at a strength of about 95,000 psi, the elongation of annealed type 302 stainless in 2 in. was something over 60 per cent. Cold working the material at room temperature to get a strength of 170,000 psi reduced the ductility to a point where the elongation was 7 per cent. When the cold working was performed at –105 F, 170,000 psi strength was attained with a ductility of 20 per cent elongation. By cold working to 170,000 psi at –320 F, the elongation was 25 per cent.

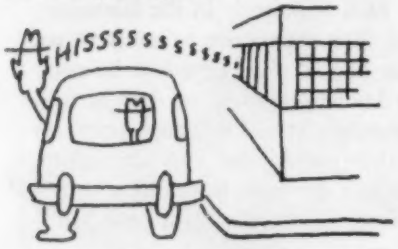
Looking at it another way, by working stainless steels at sub-zero temperatures, they can be strengthened to a higher degree with the same amount of cold working as that needed at room temperatures. Type 302, for example, has a tensile strength of about 160,000 psi when cold worked to a 40 per cent reduction at room temperature. But when reduced the same amount at –320 F, it becomes a 250,000 psi material. At ordinary temperatures, the austenitic stainless steels with the lowest nickel to chromium ratio are the most easily work hardened. At sub-zero temperatures, the same relationship holds true. Of interest is that type 302 (18-8 composition) worked at sub-zero temperatures greatly exceeds the room-temperature-worked performance of type 301 (17-7 composition). For fabricators, cold rolled tempers, now available in several degrees of hardness, can be formed more successfully at sub-zero temperatures. When warmed up to room temperatures and fabricated, the steels keep the qualities gained while being worked cold.

Stainless steel as a structural material with a tensile strength of 150,000 psi is used principally in the transportation field. If sub-zero cold working could be developed, designers would have a material of 250,000 psi with which to work. Thinner materials could be used. But the main problem is to develop an economical technique to get the metal to the cold working machine in a chilled condition. The stock to be processed can be refrigerated in a liquid bath. Dry ice in liquids like alcohol, chloroform and carbon tetrachloride will drop the temperature to –100 F; liquid nitrogen will take it down to –320 F.

(continued on page 7)

PLEASE, TELL US

The other day, one of our representative's salesmen, who had been picking up a lot of new air valve business, took the division manager out to show him how. He stopped in front of a likely looking plant, stuck his head out of the car and...listened! Sure enuff, thru the rest of the noises you could hear the hiss of air escaping. They went in and, you guessed it, a dud; no air valves in that plant. After two more such failures, the guy was ready to have his ears and head examined. A friendly passer-by restored his confidence by pointing out that his left rear tire was getting low.



Moral: If your interest in our ads is slowly leaking away because we are leaving out what you are most interested in, will you take half a minute and set us straight? Please, check only items you consider important when you want to read about air valves, and add your own comments.

- ☐ pressure range
- ☐ pipe sizes
- ☐ porting arrangement
- ☐ mounting arrangement
- ☐ leakage
- ☐ method of operation
- ☐ throttling
- ☐ materials
- ☐ dimensions of the valves
- ☐ handle load
- ☐ rate of flow
- ☐ typical installations
- ☐ user experience stories
- ☐ service data

remarks_____

_____

I specify, order or requisition air valves for use in our plant ☐ for use on equipment we manufacture ☐ for pressures under 250 P.S.I. ☐ under 2000 P.S.I. ☐ under 4000 P.S.I. ☐ over 4000 P.S.I. ☐

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Company_____

Address_____

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To get more useful information, let us know what you want in your valves. Our future ads will tell you how this vote came out. Clip out this tally sheet and send it to Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, California, and we will forward you immediately our air valve catalog.

SHEAR-SEAL AIR VALVES

LONG SERVICE

LOW MAINTENANCE

A review of the patented "Shear-Seal" principle reveals the secret of its success. The sealing surface of the self aligning tubular seal and the mating surface of the rotor are in constant intimate contact. Flow is through the seals, never across sealing surfaces. Actually, their sealing quality improves with use, as a result of the lapping action of each valve operation. These characteristic design features of long lived, service-free operation are borne out by users' experience, particularly in the control of unlubricated air or other dry gases.

EASY THROTTLING

The excellent throttling possible with these valves is again a direct result of the "Shear-Seal" design. As there is no spool or poppet to buck the force of flow, the handle moves with equal ease whether you open the valve a little or a lot.

RUST FREE MATERIALS

Corrosion is banned from Barksdale air valves and with it the resultant binding and galling; only rust free materials are used, such as stainless steel, bronze, aluminum, etc.

If all that sounds expensive, it is not; the ¼" valve for 250 P.S.I. service retails for $18.50, less O.E.M. and quantity discounts.

250 P.S.I. SERIES

Manually and foot operated 4-way valves. Available with spring return to center, to reverse or without spring return. Port sizes ¼" and ⅜" N.P.T.

2000 P.S.I. SERIES

Manually operated 4-way valves with open center or closed center flow pattern. Available in standard porting from ¼" to 1½" N.P.T. or equivalent sizes of manifold porting. Manually operated manipulator valves with normally open or normally closed center, in standard porting from ¼" to 1" N.P.T.

Manually operated shut-off valves in standard porting from ¼" to 1" N.P.T.

4000 P.S.I. SERIES

Manually operated 4-way valves in standard porting from ¼" to 1½" N.P.T. and manifold porting equivalent to ¼" only.

Manually operated shut-off valves in standard porting from ¼" through 1½" N.P.T.

The complete range of air valves is fully catalogued in bulletin A-5.

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Developments to Watch

A HYDRAULIC MOTOR . . . .

. . . . a piston type accumulator, an engine driven pump, a reservoir, and a manual pump comprise the Hydrostarter, General Motors Corp.'s new hydraulic starting system for diesel engines. No outside source of energy is needed. After the accumulator has been loaded and sealed with an inert gas, an engine-driven pump maintains pressure, and the manual pump permits emergency recharging. The starter was designed to operate in remote installations, and can eliminate the need for heavy duty electrical systems. Static torque is 80 ft.-lb. at 3000 psi working pressure. The starter can be coupled to almost all diesel engines up to 300 hp.

THERE IS NO INSIDE WELD BEAD ON TUBING . . .

. . . . as a result of a new welding process recently patented by the Trent Tube Co., East Troy, Wis., a subsidiary of Crucible Steel Co. of America. Other improvements are: better physical properties, corrosion resistance, and appearance. The process uses the inert-gas shielded arc process, with the arc struck between a non-consumable tungsten electrode. The weld is a fusion of the butted edges of the strip. The only change involved is that the rolls of the continuous mill are inverted, and the formed tubing welded from the underside, with gravity eliminating the weld bead on the I.D. The new tubing is said to have better mechanical properties, improving cold working or drawing, and fabrication. Corrosion resistance is better because the absence of valleys or grooves leaves no place for solids to deposit.

CREEP OF HIGH-PURITY NICKEL . . . .

. . . . has been studied by the National Bureau of Standards as part of a long-range research program in this field. Tests of annealed specimens were made under constant load at 300, 700, 900, and 1200 F. The results should be of interest because of the relatively low temperature at which creep takes place in nickel, and the current wide use of nickel alloys in jet engines, and other high temperature applications. At 300 F the nickel had a high resistance to creep at all stresses up to 45,000 psi. But with a further increase in stress of only 500 psi, the secondary creep rate increased by a factor of 100,000. Strain aging was particularly prominent at 300 F. This was shown in an increased creep life of specimens loaded slowly to stresses in excess of the tensile strength (46,400 psi) at this temperature. Cracks of microscopic dimensions were not found to be the cause of the third stage of creep (an increasing rate ending in fracture).

THE SALARY OF A PROFESSIONAL ENGINEER . . . .

. . . . increased most between 1952 and 1954 for engineers at the lower end of the income scale, according to a recent report published by the National Society of Professional Engineers. This is based on a survey of over 14,000 professional engineers. For the engineer in the lower quarter (about $6,900), his income increased 9 per cent over the past three years; for the engineer in the upper quarter (about $11,500), his income increased 6.6 per cent. Executive-Administrative work, and design were chief occupations of the engineers in the survey. About ⅓ and ¼ respectively, reported this as their principal work areas. The average annual salary of the Chemical Engineer ($9,730) was $1,000 better than that of a Mechanical Engineer, and $1,200 better than that of the Electrical Engineer. Civil was the lowest with $7,880. (*Continued on page 9*)

How Farval lubrication makes a turbine behave!

FARVAL—
Studies in Centralized Lubrication
No. 171

THIS hydraulic turbine had costly maintenance problems. Every few months, 6 to 8 expensive bearings had to be replaced. Old-fashioned grease gunning just couldn't keep lubricant in bearings. Repairs interfered with electric power production.

Farval Lubrication Engineers were called in. A Farval System of Centralized Lubrication exactly suited to the turbine's needs was recommended. Result—lubrication troubles ended. Downtime was eliminated. Now, even bearings under water keep working properly. Farval works as the turbine operates—no time out for lubrication. Manpower is saved, because Farval is wholly automatic. Important money is saved. In 14 years, the manager reports thousands saved in bearings and lubricant. These savings led to Farval Systems on 9 other turbines.

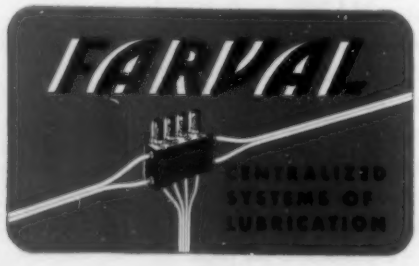
Farval saves in many industries

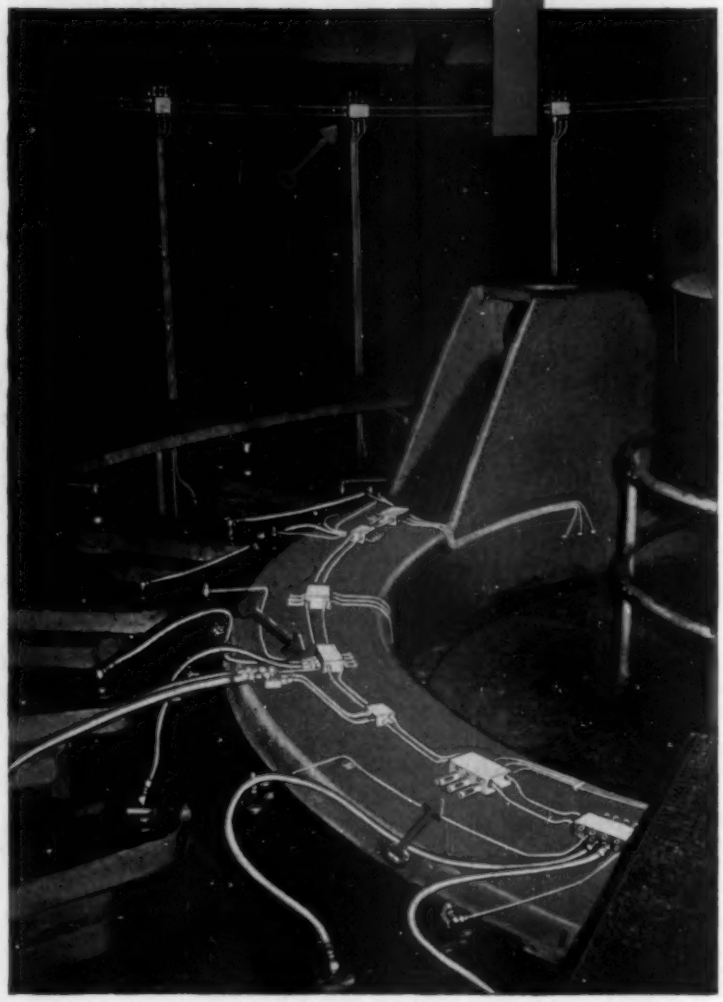
This is a typical example of the economies Farval brings to industrial equipment. Farval is a simple, dependable system that lubricates quickly, without shutdown, from one central pumping station. Oil or grease is delivered unfailingly, to each bearing served, in the exact amount *when* required. And, Farval Centralized Lubrication Systems, manual or automatic, can be installed on new or old equipment.

Free Bulletin tells you all

Find out how Farval can save for you and pay for itself in quick order. Write for helpful technical advice and ask for Bulletin 26. The Farval Corporation, **3279** East 80th Street, Cleveland 4, Ohio.

'Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.





KEYS TO ADEQUATE LUBRICATION — **Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station — you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.**

Developments to Watch

A NEW GROUP OF TITANIUM ALLOYS . . . .

. . . . has been developed by the metallurgical department of the Royal Aircraft Establishment, Farnborough, England, and were shown there recently at the Golden Jubilee Exhibition. These are destined for use as skin and structure components in supersonic aircraft. One alloy is titanium-vanadium, and another titanium-molybdenum, with the percentage of alloying elements being up to 16 per cent. These metals show very high strength at 750 F, regarded as the skin temperature of higher mach numbers. Tensile strength is 194,000 psi.

CONTINUOUS MOLDING PROCESS FOR RUBBER . . . .

. . . . offering, theoretically, rubber in unlimited lengths, also is reported to be more accurate than the extrusion process in the production of rubber parts. In addition, the new molded rubber can use softer stock which is easier to compress. Its developers, the U. S. Rubber Co., say that the rubber can be cut to the exact length, eliminating scrap, and reducing the cost of the spliced part. Also under production are forms for concrete slabs and engine mountings, seals for double windows, and windshield wiper tubing.

A VOLUME METER FOR LARGE TANKS . . . .

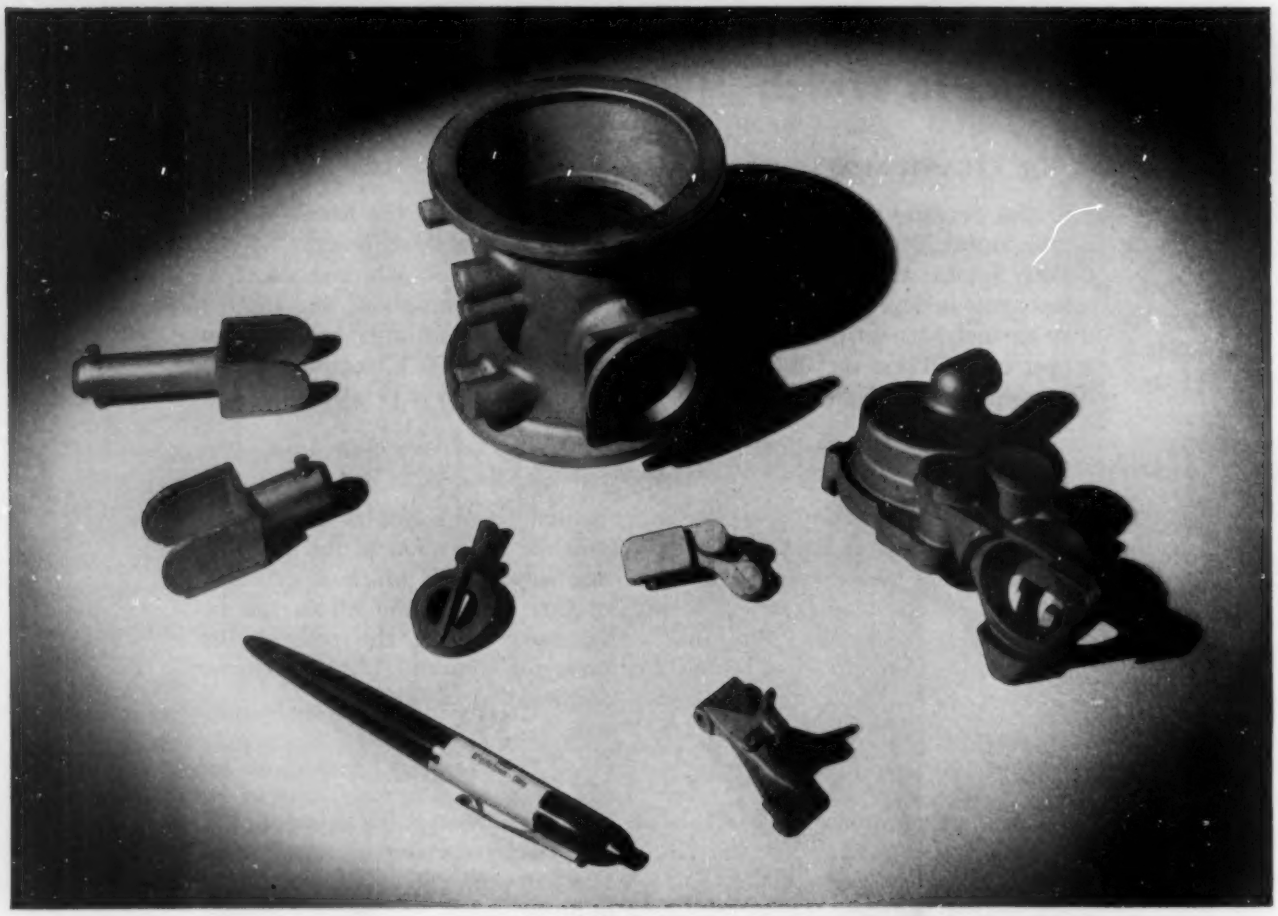
. . . . will measure surface level movements of 0.02 millimeter. Designed for the Swedish subsidiary of the Vacuum Oil Co., the meter operates by transmitting oil pressure to a mercury manometer in a transparent pipe, which is enclosed in a heat insulating material. Through a section in the insulation, the mercury column is read with a microscope. Unless temperature variations are rapid in such large volumes, error is below 1/20,000 of the total liquid pressure measured.

A TEST PROGRAM ON SHEET TITANIUM ALLOY . . . .

. . . . has been planned by the Department of Defense Steering group on Titanium Research and Development. The sheet will be rolled commercially, and first tested to develop complete engineering data before being made available to airframe and engine manufacturers for fabrication studies. Battelle Institute will start a study of the delayed cracking common to parts made from the 8 per cent manganese alloy sheet. Others in the program are: Rem Cru Titanium, Inc.; Mallory-Sharon Titanium Corp.; Republic Steel Corp.; and Titanium Metals Corporation.

AND IN ADDITION . . . .

. . . . The Air Force is now test flying the first jet-powered vertical take-off plane; designer is Ryan Aeronautical Co. . . . . Estimates are that 30 per cent of country's brass mill capacity was knocked out by the recent floods in New England . . . . . Increased foreign sales is responsible for Western Europe's great increase in motor vehicle production; these countries now manufacture almost three-fourths of all vehicles exported to world markets, while the U. S. accounts for about one-fourth; before the war the U. S. share was 50 per cent. . . . .An actute selenium shortage, caused by the recent copper strikes, has forced the shut-down of several selenium rectifier manufacturers; all users are urged to return discarded rectifiers to the manufacturers for the reclamation of the high-purity selenium. . . . .The Riegel Paper Corp., 260 Madison Ave., N. Y. 16, N. Y., wants to know who can use its latest development—a paper that is extremely resistant to the passage of oil, water, and other liquids, but which will transmit air freely.



Stainless castings show up to 190,000 psi strength after 875 F hardening treatment

Foundries report ultimate tensile strength as high as 190,000 psi in investment castings of Armco 17-4 PH Stainless Steel. This precipitation-hardening grade is easy to cast. It fills thin sections and details nicely, surface finish is good and tolerances small.

READILY MACHINABLE Armco 17-4 PH investment castings machine readily to an excellent surface finish. The subsequent 1-hour hardening treatment at 875 degrees F will not distort the part nor damage the surface. It causes only a slight discoloration.

NUMEROUS SUPPLIERS Armco does not make castings. If you are interested in high-strength, low-temperature hardening castings with high corrosion resistance, just fill out the coupon. We'll send you a list of suppliers of investment castings and other types made of Armco 17-4 PH Stainless Steel.

Armco Steel Corporation 1345 Curtis Street, Middletown, Ohio
Send me a list of producers of castings of Armco 17-4 PH Stainless Steel.

Name:_____

Firm:_____

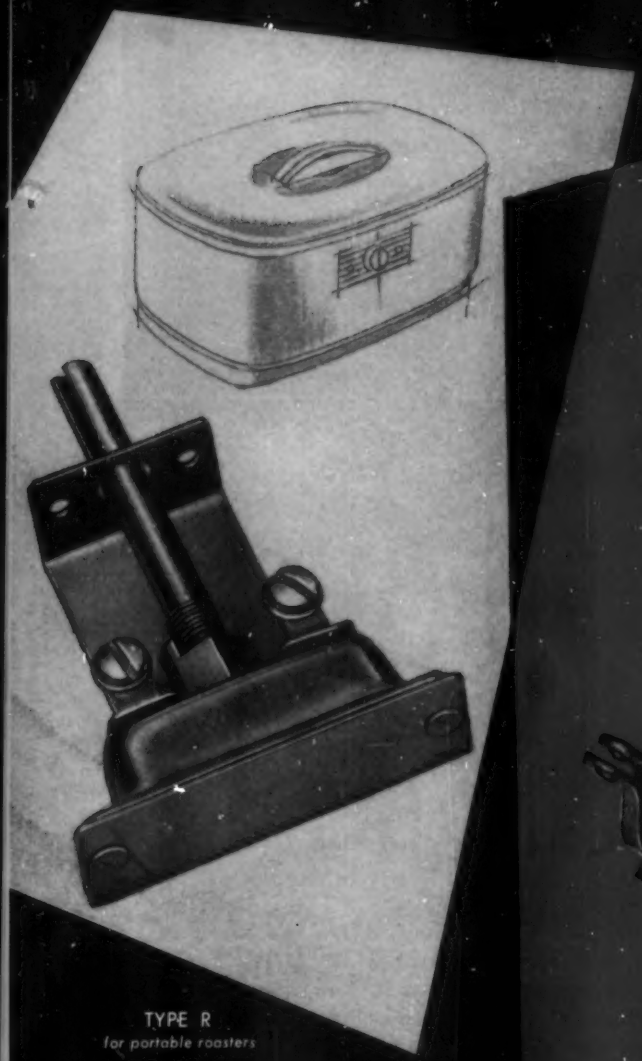
Street:_____

City:_____ Zone:_____ State:_____

ARMCO STEEL CORPORATION 1345 CURTIS STREET, MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • ARMCO INTERNATIONAL CORPORATION



TYPE R
for portable roasters

TYPE SA
for automatic percolators

TYPE S
for steam or dry irons with multiple heats

THERMOSTATS

to whet a designer's imagination . . .

With competitive conditions ahead, you're probably reappraising your product. Or designing a new one. Either way, with Stemco thermostats on the job there's every chance you'll improve performance . . . solve production headaches . . . lower costs.

No other line of bimetal thermostats has as many different styles in production. So if you want close control, compactness, light weight—you'll find them all in Stemco thermostats. Combined with Stevens application engineering service, you profit from important savings of being able to use a production line Stemco thermostat for your special needs.

Let's match our experience and enthusiasm against an hour of your time. A card or call will bring our representative on the double.

STEMCO thermostats

sensitive • close control
quick acting • positive acting
snap acting • shock resistant
light • compact • adjustable
non-adjustable
open type
hermetically sealed

STEVENS manufacturing company, inc.
Mansfield, Ohio

WHY ZINC RATES FIRST IN DIE CASTING • NUMBER 5 OF A SERIES

fine appearance as demanded by SCHICK INCORPORATED

The brand-new Schick "25" electric shaver, commemorating Schick's Silver Jubilee, not only is claimed to be a completely new concept in electric shaving, but demonstrates the outstanding results of the latest techniques in precision product engineering. The "business end" of the palm-sized new "25" is composed essentially of the four ZINC die castings illustrated above. When chromium plated, these metal components contrast beautifully with the gleaming white plastic housing.

The ZINC die castings are shown as they are received by Schick from the die caster. Not only are all assembly elements accurately cast, but the design details (note the raised trade mark and the recessed lettering on the nameplate) are sharply defined. *No machining is required* and, since the castings are ZINC, standard plating procedures are used. The right and left hand "whisk-its" (which snap open for easy cleaning) and the shearing head divider are bright chrome. The nameplate is finished in a soft silvery satin with the recessed lettering painted black to provide quick product identification.

Appearance is just one of many considerations which dictate the choice of ZINC die castings in product engineering. Send for our brochure and contact any commercial die caster for the answers to your particular production problems.

The New Jersey Zinc Company, 160 Front Street, New York 38, N. Y.

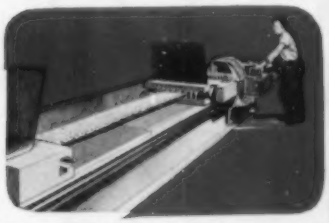
ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

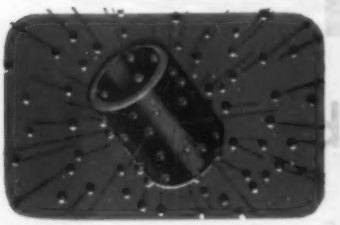
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

These LINK-BELT Roller Chain EXTRAS
put more life into your machines

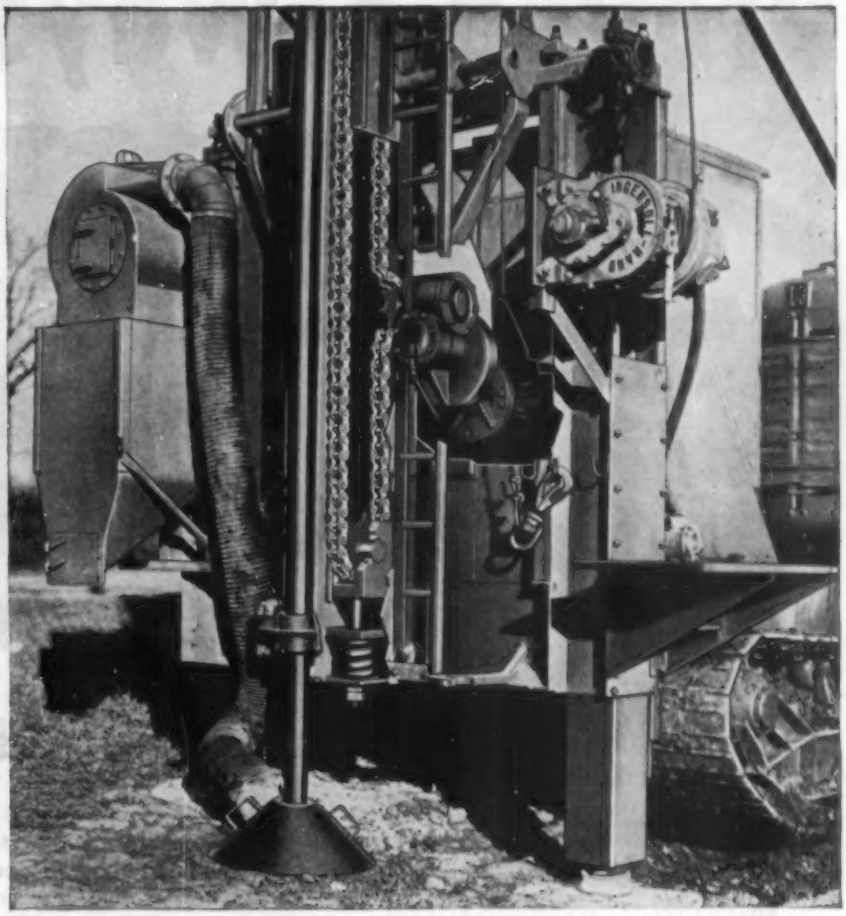
LOCK-TYPE BUSHINGS (applied on a range of sizes) end a common cause of stiff chain.



PRE-STRESSING of multiple width chain provides uniform load distribution.



SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.



Ingersoll-Rand uses Link-Belt Precision Steel Roller Chain for positive drill feed on their Quarrymaster primary blast-hole drill.

THROUGHOUT every stage of manufacture, Link-Belt takes *extra* care to build *extra* life into Precision Steel Roller Chain. Shown above are three of these added refinements . . . and there are many others which contribute to better performance and longer life for your machines.

You can choose from a wide range of Link-Belt roller chains and sprockets. In addition, Link-Belt's complete line includes silent chain drives . . . and all sizes and types of cast, combination, forged and fabricated steel chain.

Data Book 2457 will aid you in selecting and ordering roller chain. Get your copy from the nearest Link-Belt office now. And remember to see Link-Belt for all your drive and conveying chain needs.

LINK-BELT

CHAINS and SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

18,720

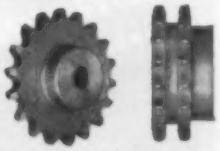
No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line

Silent Chain

LXS Steel Chain

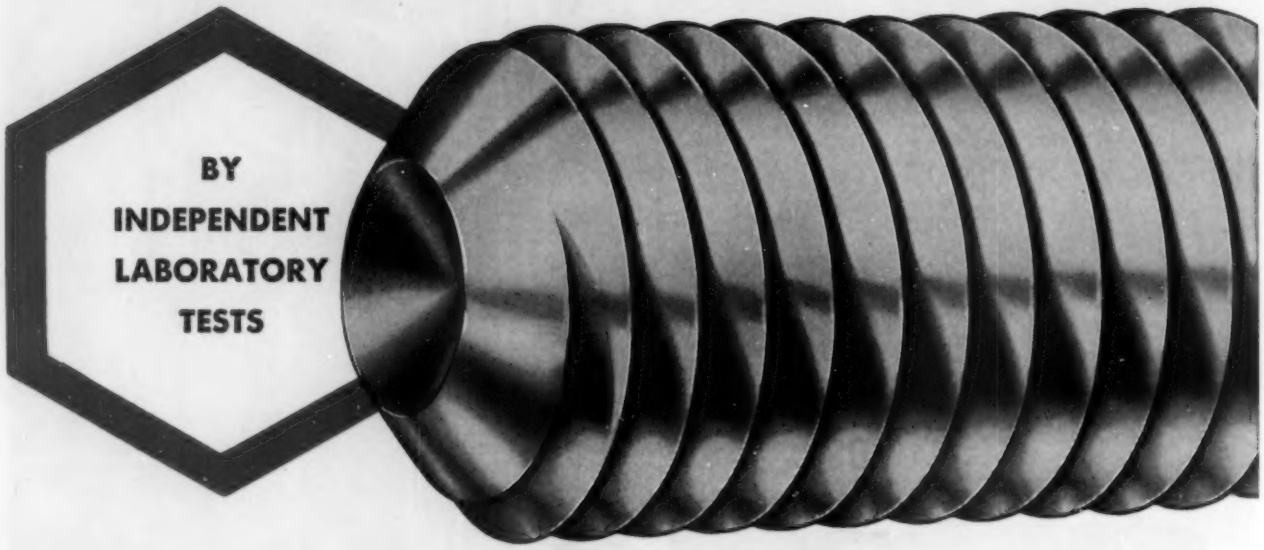
Detachable Steel Link-Belt

S-815 Flat-Top Chain



Cast and Cut-Tooth Sprockets

ALLENPOINT SET SCREWS Proved 5 Ways Better



Tested by a prominent independent laboratory against standard cup point and serrated point set screws, Allenpoint socket screws topped them all. In every test — carefully set up to simulate actual installations — Allenpoints outperformed and outlasted competing set screws.

***BETTER* Cup Point Pattern**

Allenpoints make the all-important full circle pattern when tightened up to *ordinary* pressure — the normal force exerted to tighten a socket screw by hand.

***BETTER* Resistance to Rotation**

Deep driven Allenpoints hold longer under increasing torsional strain than any other set screw tested.

***BETTER* Cup Point Depth**

The deeper they drive the tighter they hold. Allenpoints — again at average wrenching pressure — penetrate smoothly and deeply with no gouging, no cutting action.

***BETTER* Resistance to Longitudinal Thrust**

Tighten an Allenpoint held collar to a shaft with a wrenching pressure of only 150 inch pounds. It will take 1200 lbs. of longitudinal thrust to start that collar along the shaft. No pipe extension, no twisted wrenches to get effective tightening pressure. Allenpoints hold tightly at average *hand wrenching* pressure.

***BETTER* at Withstanding Vibration**

Long after other set screws loosen their grip, Allenpoints hold firm under repeated vibration.

Write our Advertising Department for a detailed, technical brochure on these comparative tests. It's got the facts on the Allenpoint story.

ALLEN HEAD

ALLEN

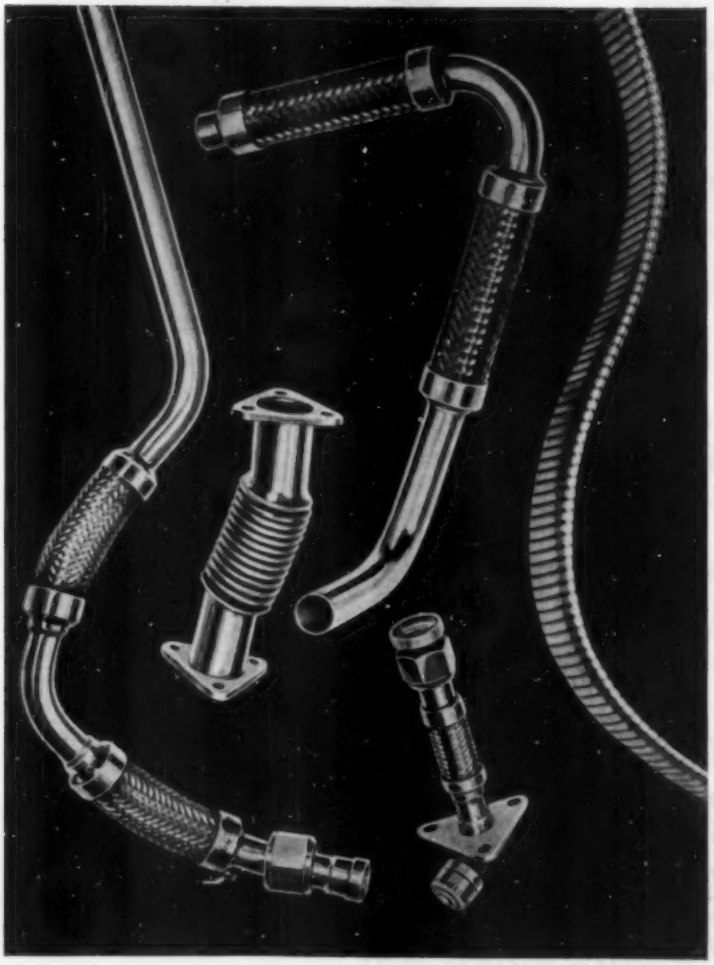
MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.

Sold Only Through Leading Industrial Distributors.

Specify Genuine Allenpoint Set Screws.

Standard AMERICAN flexible connectors like these may solve your problem . . .

If not, we'll design a "special" at no extra cost



What's your connector problem? Vibration? Movement? Misalignment? Cramped space? Want help solving it? Tell us what material you have to convey, temperatures and pressures involved, kind of end fittings you need, and the special conditions which will affect service. Our engineers will be glad to work with you. *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.* In Canada: *The Canadian Fairbanks-Morse Co., Ltd.*

55178

WHEREVER CONNECTORS MUST MOVE

AMERICAN

flexible metal hose and tubing

an ANACONDA® product

PRE

FREE CATALOG . . . 16 pages of data on the complete line of American Flexible Metal Hose and Tubing, including fittings. Mail coupon to The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.

NAME.....

COMPANY.....

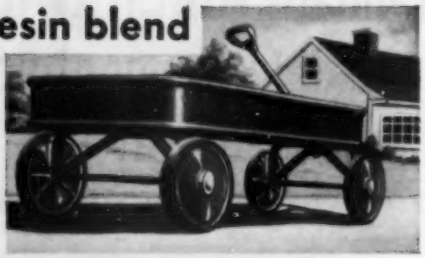
STREET.....

CITY.....ZONE....STATE.....

Look for

wheels that are practically wear-proof!

Made of KRALASTIC a rubber-resin blend



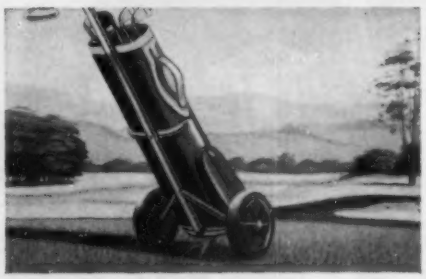
Kralastic rubber-resin—proved so outstanding in water meter covers, underground pipe, and in hundreds of other *tough* applications—now gives *wheels* wonderful new *selling* properties!

A leading lawn-mower wheel manufacturer found Kralastic wheels *far* superior to conventional steel or aluminum wheels. And dozens of end product manufacturers are already beginning to incorporate them in *their* products.

Look at the advantages Kralastic wheels offer and you'll see why!

- **lighter than aluminum!**
- **smooth, quiet running—never need oil!**
- **can't rust, rot, or corrode!**
- **will bounce ten feet high from concrete—unharmed!**
- **abrasion resistant!**
- **non-warping, resistant to weather and most chemicals!**
- **thoroughly, permanently colored!**
- **quickly injection molded—relatively inexpensive!**

Look for Kralastic in the products *you* buy and sell—in wheels, drawer slides, pulleys—wherever toughness and lack of friction are important. *Feature the advantages Kralastic offers.* It will help you sell the *complete product.*



And if you're a manufacturer, see what Kralastic® can mean to *you.* Write us today.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

Added Evidence that . . .

Everyone Can Count on VEEDER-ROOT

In figuring out new systems of automatic electrical control, Veeder-Root *Count*rol can supply vital connecting links. For instance, this Predetermining Counter can be hooked into such a system to light a light, ring a bell, or actuate a mechanism to stop a machine or process *at any pre-set point*. And there are many other Veeder-Root Counters that can serve as "countponents" in almost any way desired. Or special counters can be designed for specific applications. Engineers in any industry, now engaged in working out automatic control systems, can count on Veeder-Root engineers to work with them on any problem where reliable facts-in-figures are needed.

VEEDER-ROOT INCORPORATED • Hartford 2, Connecticut

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada
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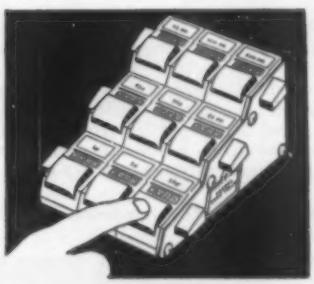
"The Name That Counts"

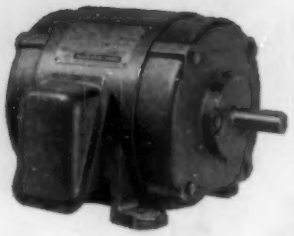


New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide. Write for news sheet and prices.

Mechanical

Where moderate speed range is required and where machine may be stopped to make speed changes. Horsepower range—1½ to 300. Speed adjustment range—9 to 28 percent. Two *Vari-Pitch* sheaves used together double range of adjustment.

Combination starter



Squirrel-cage motor

Vari-Pitch stationary control drive

Mechanical

Where infrequent change of speed in low horsepower drives is required and machine may be stopped for speed adjustment. Especially suitable for fan drives, stokers, small pumps and tools. Horsepower range—fractional to 4 hp. Speed adjustment range—18 to 50 percent. Use of two adjustable sheaves doubles speed adjustment range.

Across-the-line starter

Squirrel-cage motor

Texrope adjustable drive

EIGHT WAYS TO GET VARIABLE SPEED

Electrical

Where stepped speed control is satisfactory. Available with stepless control in larger sizes by using liquid rheostat. Speed is varied by means of control on secondary windings of motor. Horsepower range—5 hp and up. Speed adjustment range—50 percent of synchronous speed to full load speed.

Wound-rotor motor control

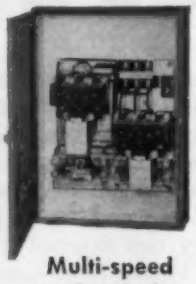
Wound-rotor motor

Texrope V-belt drive

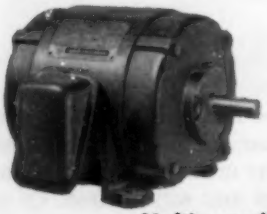
Electrical

Where a few definite speeds are required. Up to four speeds available from one motor. Motor is built on standard squirrel-cage frame with special windings and control. Furnished for variable torque, constant torque and constant horsepower. Horsepower range—½ hp up.

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.



Multi-speed motor starter



Multi-speed squirrel-cage motor

Texrope V-belt drive

Write for Engineering Literature

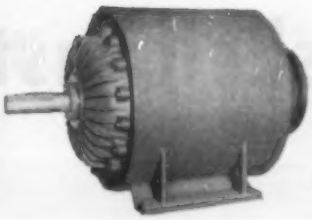
A-C ALLIS CHALMERS

ALLIS-

Mechanical

Where speed must be changed while machine is in motion. Particularly good for machines requiring fine adjustment while operating. Double range of adjustment may be obtained by using two *Vari-Pitch* sheaves. Horsepower range—1½ to 600. Speed adjustment range—9 to 28 percent with one *Vari-Pitch* sheave.

Reduced voltage starter



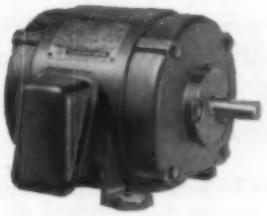
Squirrel-cage motor

Vari-Pitch motion control drive

Mechanical

Where very wide range speed control is required or where enclosed unit is desired. May be manually or remotely controlled. Motor may be mounted on speed changer housing for compact installation. Horsepower range—1½ to 75. Speed adjustment range—3¾ to 1.

Across-the-line starter



Squirrel-cage motor

Vari-Pitch speed changer

COMPLETE DRIVES from One Reliable Source

Electrical

Where great versatility is required. Speed may be varied by various types of control, either stepped or stepless. For both constant and variable torque loads. Horsepower range—½ hp up. Speed adjustment range—zero to maximum speed. Maximum speed in smaller sizes, 3500 rpm.

Direct current control

Direct current motor

Texrope V-belt drive

Combination

Where extremely wide range is required, a combination drive adds the speed control range of the motor to that of the *Vari-Pitch* drive. Hundreds of combinations of any of the above units can be worked out to fit the requirements of a particular design.

Wound-rotor motor control

Wound-rotor motor

Vari-Pitch motion control drive

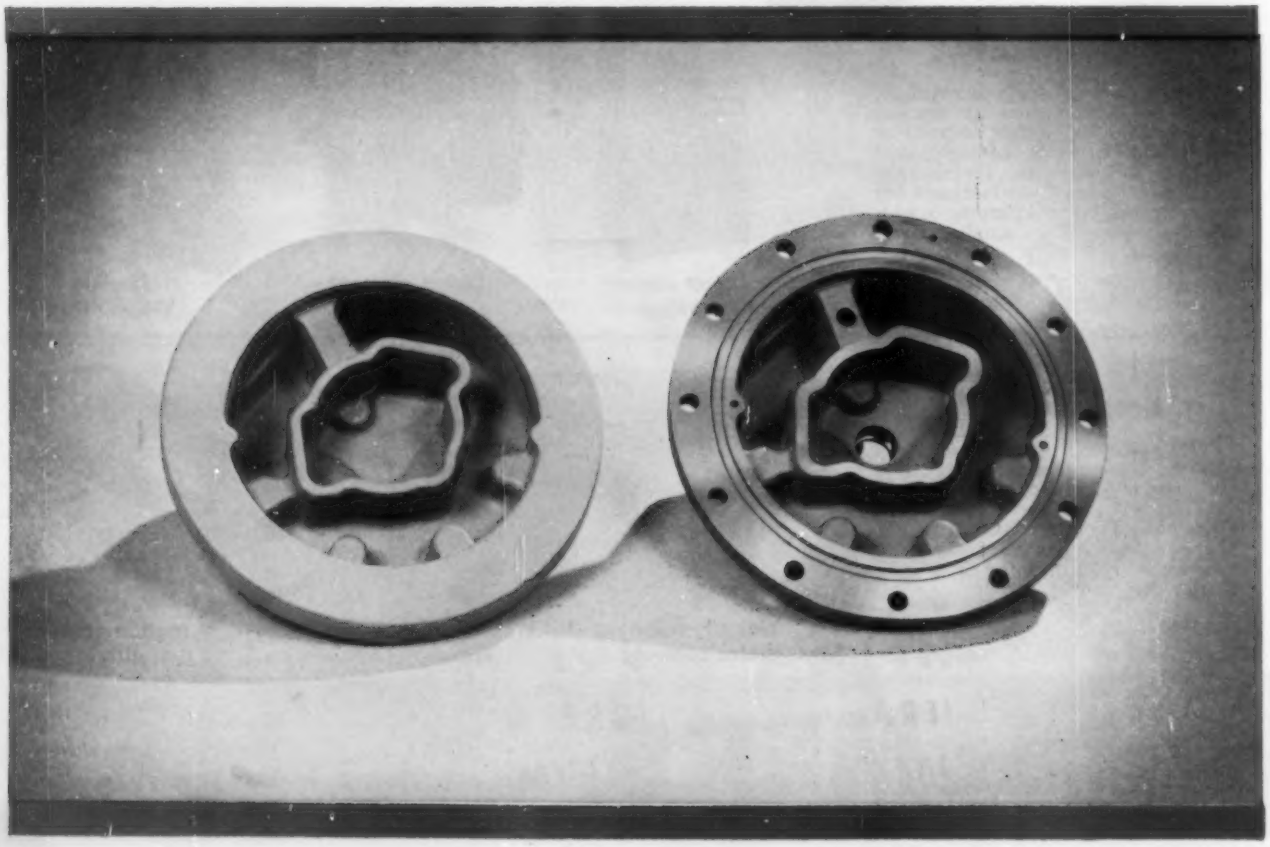
A4523

CHALMERS Milwaukee 1, Wisconsin

How shell castings + ArmaSteel

This compressor head casting for an air conditioning unit produced by Central Foundry Division is a good example of the improvements and savings so often realized when ArmaSteel and shell castings are combined. This part is subjected to high chamber pressures and must be free of vapor leaks. ArmaSteel has the ideal physical properties for this job including good machinability.

The shell casting process supplies clean, sand-free casting surfaces and greater dimensional uniformity which eliminates costly machining in the chamber, on the O.D. and profile milling on the contour. Thus, by using the shell casting process together with ArmaSteel in this part, material is saved, machining is saved, scrap losses are reduced 80%, and . . . due to ArmaSteel's high physical properties . . . a greatly improved product results.



= savings for you

Here are two more parts improved by shell casting. The Crankshaft Sprocket was formerly machined from bar stock on automatic screw machines. By the use of shell castings on automatic chucking machines, material and machining were saved and a product with greater performance resulted.

Rocker Arms are a typical example where the uniformity of shell castings has made the part more adaptable to automatic machining. Preliminary grinding on pad ends has been eliminated, leaving only a finish grind. Center hole is cast with a minimum of finish stock eliminating a preliminary drilling operation.

In **SHELL CASTING** the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages:

- **Greater uniformity**
- **Closer tolerances . . . reduced finish allowances**
- **Greater accuracy which makes intricate designs possible**
- **Improved casting surfaces**
- **Freedom from residual sand**
- **Less excess metal resulting in lower freight charges**
- **Longer tool life**

ARMASTEEL is an arrested malleable iron of pearlitic structure. The size and arrangement of carbon nodules in this pearlite result in a freely machining material that has the strength and performance characteristics usually associated with carbon steel forgings. Thus ArmaSteel offers you:

- **Uniform structure**
- **Good machinability**
- **Excellent bearing properties**
- **Good wear resistance under heavy loads at high speeds**
- **Long fatigue life, high yield strength, maximum rigidity**
- **Good damping capacity**
- **Adaptability to selective hardening**

For further information about shell or sand castings, ArmaSteel, malleable iron or grey iron castings, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION ·

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN • DEPT. 10

Two-year-old test driver reports on "Nylok" Nuts

"Ever watch a two-year-old like me in action? I'll give any piece of equipment a good shakedown and testing. Did it recently on my new Taylor-Tot. Figured it would be a cinch to shake it apart in nothing flat. But I'd never come up against 'Nylok' Nuts before. I gave it the full treatment—bumps, bounces, jars and jolts. The 'Nylok' Nuts held tight. Now I know why 'Nylok' Nuts mean positive locking."

The Frank F. Taylor Company had a young fellow like this in mind when it designed and engineered the Taylor-Tot. At several critical points Republic "Nylok" Nuts are used to assure positive locking even under severe shock, vibration and tension.

Republic "Nylok" Nuts lock whether seated or not. This means painted surfaces and soft metals are protected because "Nylok" Nuts do not have to be pulled up tight. Positive locking is assured in any position wherever you stop wrenching. Yet they can be backed off easily for maintenance or inspection of parts. And then can be re-used.

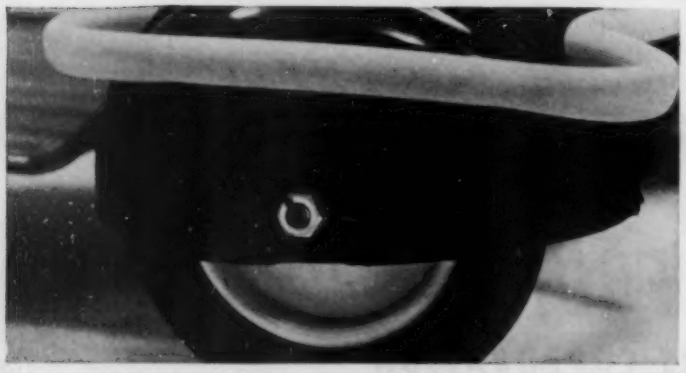
They go on easily, too, because either end is up. No special tools, lubricants or techniques are needed. Use them manually for piece-work. Or feed them automatically at full production speeds.

Think how Republic "Nylok" Nuts might be applied to your product or equipment. Why not make an actual test? Write us for a sample nut indicating size required. Available in Finished Series tapped ¼" thru 1", Finished Thick Series tapped ¼" thru ½", and Heavy Series tapped ¼" thru 1".

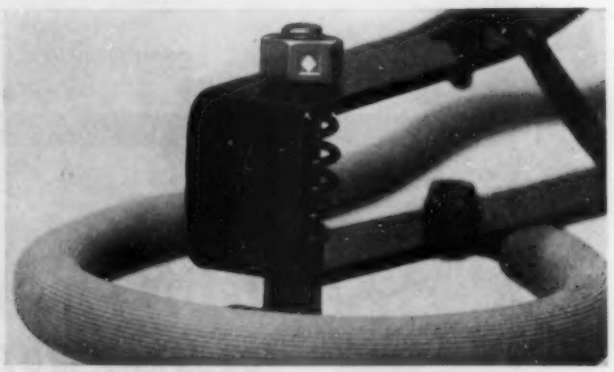
"Nylok" Nuts are but one of more than 28,000 regular types and sizes of high-quality fasteners made by Republic's Bolt and Nut Division.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products



Republic "Nylok" Nuts are used on rear wheels to assure positive locking and for ease of assembly. One-piece, cold-forged nut goes on fast from either end. There is no fumbling to find the right side. No special tools are needed for assembly.



Positive adjustment of spring compression on the Taylor-Tot's shock absorbers is accomplished with Republic "Nylok" Nuts. A nylon plug in one face forces the nut tight against the opposite threads of the stud as the nut is turned on.

MANY BUDDING YOUNG TEST DRIVERS take their first rides in bassinets made of Republic ENDURO Stainless Steel. Use of ENDURO in their construction gives these wheeled bassinets their attractive appearance. Provides adequate strength without excess weight. Makes them easy to clean and keep clean. Assures long life with minimum maintenance. It will pay you to find out more about ENDURO for your product. Mail the coupon.

REPUBLIC STEEL CORPORATION
3150 East 45th Street • Cleveland 27, Ohio

REPUBLIC STEEL

☐ Please send a sample "Nylok" Nut Size _____

☐ Please send more information on ENDURO® Stainless Steel

Name _____ *Title* _____

Company _____

Address _____

City _____ *Zone* ____ *State* ____

K-8953

Jack & Heintz customizes motor

HERE WAS THE NEED

The Toledo Scale Company, Toledo, Ohio, a leading manufacturer of modern food store and kitchen machines, needed a special motor to power its new bench-type potato peeler.

Space limitations made shape and mounting arrangements of prime importance. The motor had to operate vertically, shaft up, driving the abrasive disc through a belt reduction. Tailored torque characteristics were needed to smoothly and quickly accelerate the unbalanced loads of irregularly shaped potatoes.

Environmental problems, too, had to be solved. The motor, enclosed in the base, had to provide trouble-free service in the humidity and heat of a commercial kitchen. To solve these problems, Toledo Scale turned to Jack & Heintz.

Customized ELECTRIC

for new TOLEDO® Potato Peeler!

Space, load, environmental conditions overcome with special, rugged Jack & Heintz motor . . .

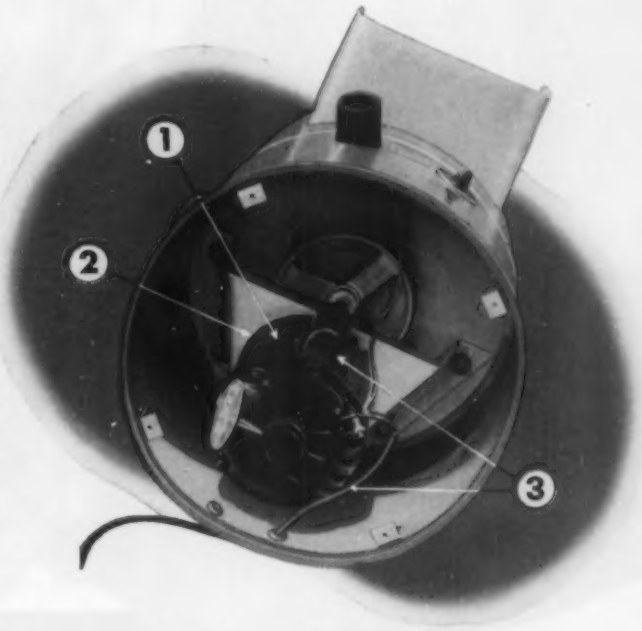
Peeling 15 pounds of potatoes in less than 75 seconds using only ⅓ hp requires an electric motor of unique capabilities . . . especially when it must operate within restricted mounting and cooling conditions.

Jack & Heintz provided a *Customized* motor to answer this specific need. Incorporating many unusual features, it assures Toledo Scale's customers efficient, smooth-running power with minimum servicing.

1. ***Special winding design*** brings motor to full rpm quickly and smoothly, delivers torque required to compensate for heavy starting loads.
2. ***Special end bell*** machining permits direct mount on housing, eliminating need for bracket assemblies or other costly connecting or reinforcing elements.
3. ***Special capacitor location*** insures clearance at sides of machine. Lead outlet positioned for convenient customer hookups.

★ ***Close-coupled drive*** keeps load point of motor near bearings for longer life, greater efficiency.

★ ***Special insulating materials*** provide trouble-free operation under high heat and moisture conditions.



DESIGN YOUR PRODUCT TO DO A JOB . . .

not to fit a motor

Avoid compromising your product design by taking advantage of an engineering philosophy that will answer your special motor needs. Design your product to do a job . . . *not to fit a motor!* Write Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

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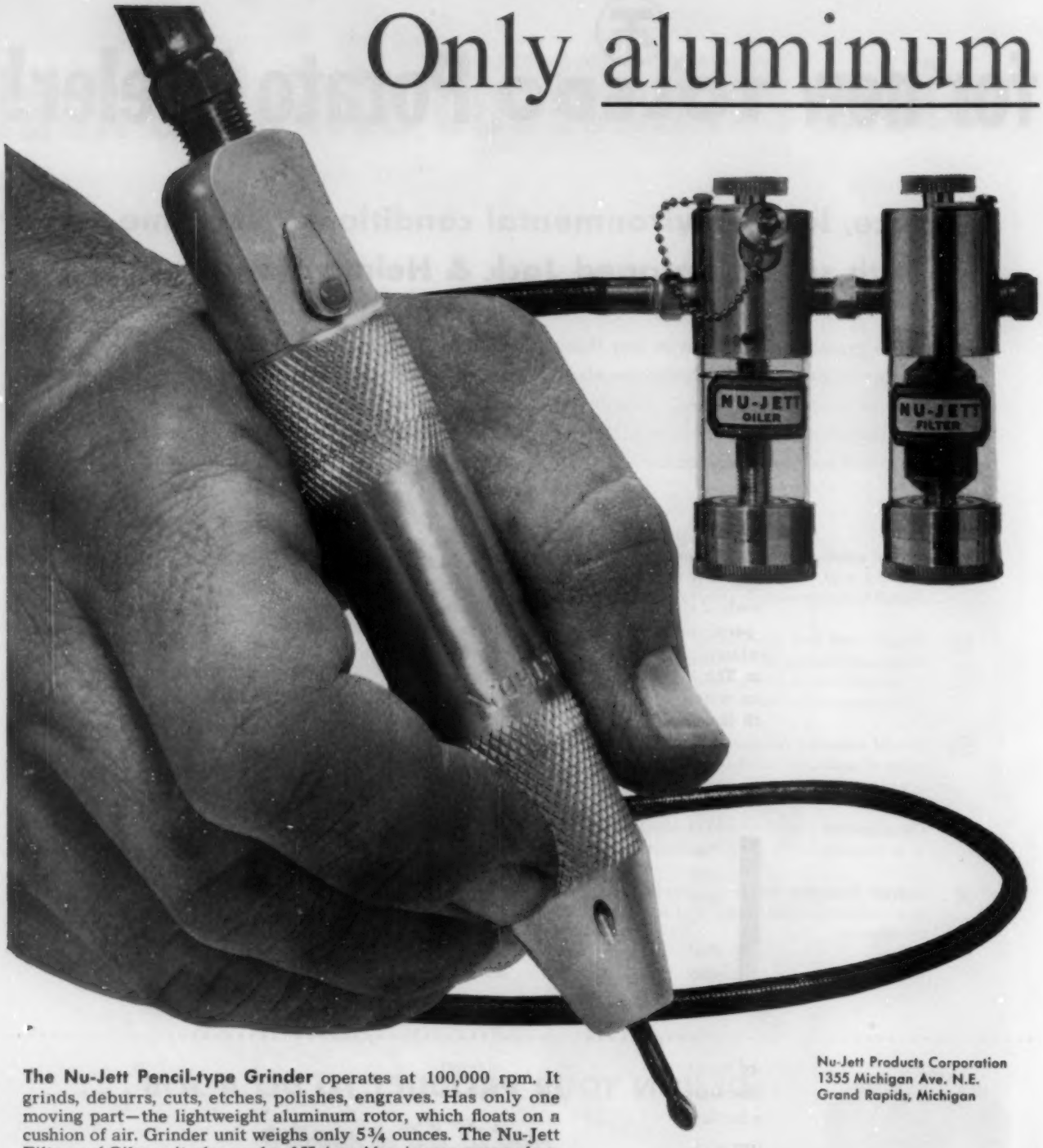
MOTORS *by* JACK & HEINTZ

Only aluminum



The Nu-Jett Pencil-type Grinder operates at 100,000 rpm. It grinds, deburrs, cuts, etches, polishes, engraves. Has only one moving part—the lightweight aluminum rotor, which floats on a cushion of air. Grinder unit weighs only 5¾ ounces. The Nu-Jett Filter and Oiler unit, also made of Kaiser Aluminum, assures clean air for the grinder, simultaneously with accurately metered oil in mist form. Units are perfect example of how Kaiser Aluminum makes possible high quality, precision products at reasonable cost.

Nu-Jett Products Corporation
1355 Michigan Ave. N.E.
Grand Rapids, Michigan

GENERAL MANAGER OF NU-JETT, Mr. William W. Peterson, says:

"Aluminum saved us 27% in costs! Aluminum's lower initial cost was a big factor in this saving. But it also provided other important savings. Its light weight gives us appreciable savings in shipping costs, including the lighter weight shipping container. Brass would have required a clear baked enamel for protection. Steel could not be considered for this product because compressed air, which runs the tool, carries moisture which would quickly rust the metal.

"One more thing: machined aluminum gives the Nu-Jett grinder a quality that puts it in a class by itself."

parts are good enough for this amazing grinder!

BECAUSE of the high performance and quality requirements of the Nu-Jett pencil-type grinder, made by the Nu-Jett Products Corporation, Grand Rapids, Michigan, *only* aluminum screw machine parts could be successfully used.

Nu-Jett found that Kaiser Aluminum was the perfect material for their grinder and filter unit. It was not only economical in raw material outlay and production costs but actually *permitted a design of higher performance characteristics!*

DESIGN ENGINEER OF NU-JETT, Mr. Charles V. Johnson, says:

"Aluminum made this grinder possible! Obviously, a pencil-type grinder that has a speed of 100,000 rpm and yet is extremely durable makes metal selection of paramount importance. In every way, aluminum was superior to other metals. The light weight aluminum rotor attains maximum rpm within 4 seconds, thus minimizes starting lag. Too much lag would result in the rotor turning in the critical vibration zone long enough to cause excessive wear on the bearings. Once started, the light aluminum rotor actually floats in the air stream. By using aluminum for virtually every part, we make the tool easy to use, with less operator fatigue.

"Aluminum's anodic finish is more resistant to the attack of salt-laden hand moisture. These, of course, are only a few of the many rewarding design experiences we have had with Kaiser Aluminum."

SCREW MACHINE FOREMAN AT NU-JETT, Mr. Arthur Moorhus, says:

"Aluminum speeds our production! In the first place, we have no difficulty in machining aluminum at the same speeds and feeds as brass, and often faster.

"We use conventional tools and tool angles for aluminum. We find that *Kaiser* Aluminum Rod runs extremely uniform. With our experience with aluminum, we like it as well as any other metal to machine."

THE Nu-Jett story is just one of many that emphasize this point: when you specify *aluminum* screw machine parts you often get *better* parts for *less money*.

A pound of Kaiser Aluminum screw machine stock gives you *three times* as many parts as a pound of brass or steel.

And these parts provide you with a unique combination of advantages, which include lightness with strength, handsome finish, corrosion resistance, excellent heat and electrical conductivity.

For more information or assistance, look for our local number in the classified telephone directory under the heading "Aluminum" or contact one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service

MOTOR CONTROL FACTS
ON INDUSTRY'S
MOST COMPLETE LINE

FACT: Here is industry's newest and most advanced high-voltage starter!

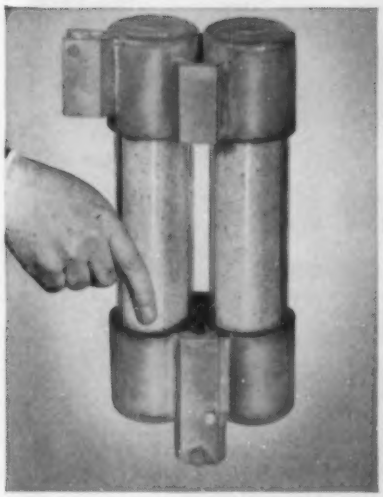
This new line of Westinghouse high-voltage fused starters offers industry more protection — more operating simplicity than any other. Here are a few reasons why:

Extension of the BAL fuse line up to 400 amperes with the first and only 400-ampere, double-barreled, single-unit fuse; a new 50,000-kva air break contactor featuring the most advanced arc interrupting action yet developed; and new enclosures providing new levels of convenience and safety.

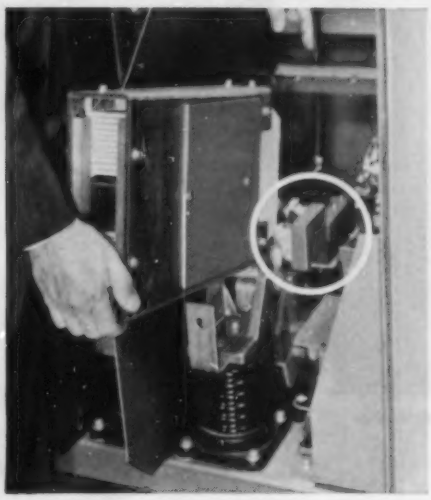
Booklet B-6535 has more facts on this outstanding new starter. Get it from your Westinghouse engineer —or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-21898

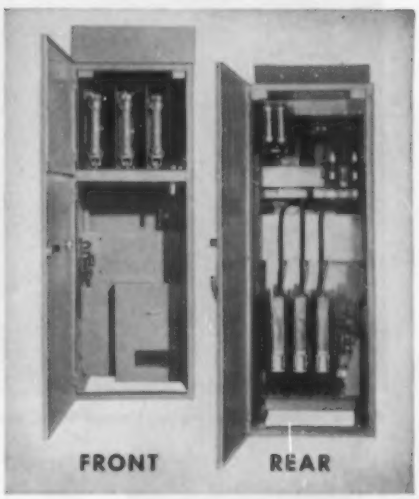
YOU CAN BE SURE... IF IT'S Westinghouse



New 400-ampere, double-barreled, type BAL fuse features "no-bolt" brazed connections which insure equal division of current. Complete coordination of fuses is assured. Exclusive BAL single-barreled design for fuses up to 200 amperes is retained.



New air break contactor (200 and 400-ampere sizes) features a unique arc chute design which greatly simplifies inspection and maintenance of the contacts. Simply pull the arc chute down —contacts are immediately and conveniently accessible.



New enclosure design provides both mechanical and electrical interlocks; front and rear access DOORS; top-mounted bus arrangements; separate compartmentation of high and low-voltage components—all designed for maximum safety of personnel.

FROM INDUSTRY'S MOST COMPLETE LINE OF INDUSTRIAL CONTROL

CONTROL COMPONENTS • MOTOR CONTROL • ELECTRONIC CONTROL • CONTROL SYSTEMS • NATIONAL SERVICES

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... and
CANADIAN
WESTINGHOUSE CO. Ltd.
Makes Sure of Top Motor Performance in Wringer Washers with

KLIXON
PROTECTORS

Klixon protected Westinghouse motor in the wringer washer

On a conventional wringer type washer, it is very important that overheat protection be provided for the motor. Theoretically this can be taken care of by a fuse in the circuit, but too often people up-rate fuses — or put pennies behind them — if trouble develops. Experience has proven that this situation is one of the biggest producers of burned out motors.

Canadian Westinghouse Co. Ltd. overcomes this problem and provides positive motor protection in their wringer washers by using a Klixon Protector in their "Thermoguard" motor protection.

Should the motor shut off because of overheating, the "Thermoguard" with the Klixon Protector snaps the power off safely. Then, to start the motor again after it has cooled, the user merely pushes a button on the outside of the washer.

Manufacturer after manufacturer of motor-driven equipment has extended the life of his motors by building in Klixon Protectors . . . automatic reset types that restart automatically . . . manual reset types that have a "red button" which can be pushed to restart.

Protect your motor-driven products by specifying and using motors with built-in Klixon Protectors. A range of sizes is now available for inherently overheat protecting small shaded pole motors — up through the largest integral horsepower motors.

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METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
910 FOREST STREET, ATTLEBORO, MASS.

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Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are metal strips for fabrication of contact parts. These kits are available at nominal cost.

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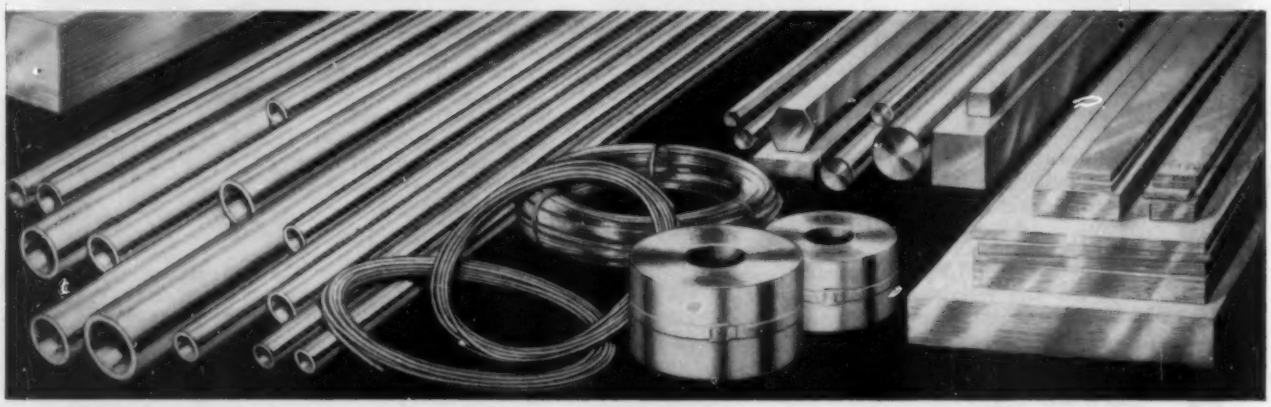

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An

ALLEN-BRADLEY *Special* CONTROL PANEL...

for which the ALLEN-BRADLEY HANDY CATALOG PROVIDES THE BUILDING BLOCKS

Use this A-B Handy Catalog as a quick-and-easy reference guide in selecting components for trouble-free control panels.

Your special control panels may be simple or they may be complex . . . but their reliable performance can be guaranteed in advance if you use the time-tested, trouble-free components listed in the A-B Handy Catalog, shown above.

In this 120-page Handy Catalog you will find the "building blocks" for any type of control panel. Every unit has a long service record of dependable performance in all kinds of industrial applications. Being "QUALITY" products, they are a sales asset to your machines.

First—there is the simple solenoid design. With only ONE MOVING PART, there are no troublemaking pins, pivots, or bearings to corrode and stick.

Second—the double break, silver alloy contacts do away with contact maintenance. You never have to file or clean the contacts on A-B controls.

Third—the Quality workmanship that goes into A-B controls is obvious at a glance. Use A-B "building blocks" for your special panels or let A-B build such panels for you!

A-B Quality

The Sign of QUALITY Motor Control

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8-55-R

The Quality Line
of Manual Motor Starters

GENERAL PURPOSE

WATERTIGHT

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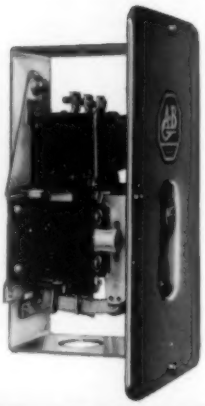
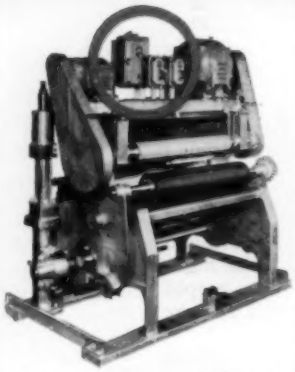
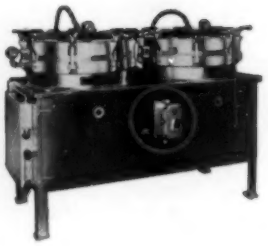


FLUSH TYPE

A-B manual starter, in NEMA 1 general purpose enclosure, on DeWalt metal cutter.



A-B manual starters, in NEMA 4 watertight enclosures, on Stehling fleshing machine.



A-B manual starter, in NEMA 7 explosion-proof enclosure, on Hilco oil reclaimer.

A-B manual starter, in Type 1B1 flush mounting, on Noble & Westbrook shell marker.

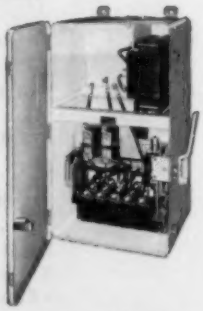
The popularity of Bulletin 609 manual starters rests on the following facts!

1—They are so simple. Few moving parts mean few chances for trouble.

2—Quick-make and quick-break switching action prevents contact "teasing."

3—Double-break, silver alloy contacts need no cleaning or filing—they are always in perfect operating condition.

4—Use of "buttons" for ON and OFF switching is in line with operation of automatic starters and is convenient for machine operator.



Bulletin 646 auto-transformer starter.

5—The two solder-pot overload breakers provide continuously dependable and accurate motor overload protection.

Be sure to send for a bulletin describing the full line of A-B Bulletin 609 manual across-the-line starters up to 5 hp, 220 v; 7½ hp, 440-550 v.

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ALLEN-BRADLEY

SOLENOID STARTERS

QUALITY

DESIGNING WITH ALUMINUM

NO. 16

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

A WELDING PROCESS IS AVAILABLE FOR EVERY PRODUCT USING ALUMINUM

Good weldability of aluminum alloys reduces the cost and improves the quality of the fabricated product.

The reliability of aluminum welds has been demonstrated by years of service in many applications. Still further developments in welding to improve the weldability of aluminum alloys have been as phenomenal in recent years as the growth of the aluminum industry itself. It is now possible to weld both heat treatable and non-heat treatable aluminum alloys. In addition, several new weldable, high strength alloys have been developed. Of equal importance are the new welding processes currently being adopted to extend the range of weldable alloys and to reduce the cost of welding. As a result of these developments, aluminum can be readily and economically welded.

Welding Processes

Spot welding of aluminum has been used for many years and continual improvements have made the process an important factor in aluminum sheet product fabrication. Pressure welding, one of the oldest methods known for joining metals, is a newcomer in aluminum fabrication. However, it holds intriguing possibilities for new applications (Fig. 1).

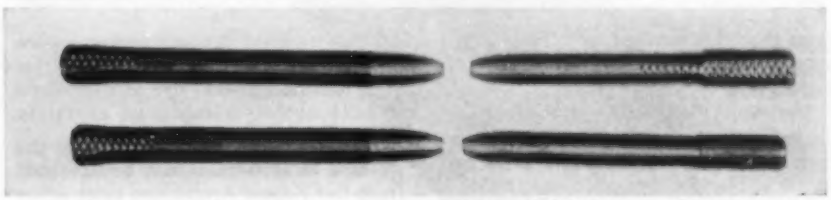


Fig. 1—Pressure welded tensile test specimen of annealed copper to 1100 aluminum ⅜" diameter rod. Fracture occurred in the aluminum with 100% joint efficiency.

Gas welding and brazing, metal arc and carbon arc welding are all suitable for joining aluminum alloys, if the proper fluxes and filler metals are used. However, two newer welding processes are admirably suited for welding aluminum.

Inert gas tungsten arc welding (TIG). This process is an important aluminum joining method. In TIG welding an arc is drawn between the work and a nonconsumable tungsten electrode in an atmosphere of argon or helium. No fluxing is required but filler material may be necessary depending on joint design. Table I shows typical welding conditions for tungsten arc welding of aluminum. TIG welding is a relatively cheap method which consistently produces high quality welds with good mechanical properties. With this welding process, flux contamination is eliminated as a source of corrosion. Welding can be performed in flat, vertical, and overhead positions by the TIG process, and distortion is minimized by the high heat input and welding speeds employed. For economy of operation, this process is recommended for sheet material thinner than ¼", although it can be used for welding fairly thick aluminum alloy plate.

TABLE I

TUNGSTEN INERT GAS ARC WELDING (TIG) CONDITIONS

Sheet Thickness	Current Amps* a-c	Wire Consumed Lbs/100 ft of Weld	Welding Speed in/min/pass	Argon Gas Flow (cfh)	No. of Passes	Diam Tungsten	Filler Rod Diam	Gas Cup Diam (in.)
1/16"	80-170*	1/2	12	16-20	1	1/16-1/8"	3/32"	3/8-1/2"
1/8"	150-250*	2	12	20-25	1	1/8-3/16"	1/8"	1/2"
3/16"	180-320*	4	12	20-30	1 or 2	1/8-3/16"	3/16"	1/2"
1/4"	250-350*	9	10	25-35	2	3/16-1/4"	3/16-1/4"	1/2-5/8"

*Using Cooled Backup Bar

Inert gas metal arc welding (MIG). MIG welding is the most important development in recent years to extend and improve the weldability of aluminum. Here an automatically fed filler wire is used to draw an arc to the base plate in a shield of inert gas. As in TIG welding, no flux is required. One of the important advantages is that relatively unskilled labor can be used to operate the equipment. With a minimum of training, operators can make sound welds, at high speeds. Because no flux is used, there is no problem of corrosion by flux residue. Distortion, cracking and similar welding problems are minimized by the high heat input and welding speeds. Table II shows typical MIG welding conditions. This process is used for welding alloy sheet thicker than ⅛" (Fig. 2), and joints in material as thick as 4" have been made successfully.

Factors Affecting Weldability of Aluminum Alloys

Weldability of aluminum alloys depends on the product, service conditions, the alloy itself and on the welding process to be used.

The aluminum surface oxide film is the most outstanding characteristic influencing the welding of aluminum alloys. Generally, this film is one of the most desirable features of this metal. However, in aluminum welding it is

PLEASE TURN TO NEXT PAGE

TABLE II

TYPICAL INERT GAS METAL ARC WELDING (MIG) CONDITIONS

Sheet Thickness	Current Amps a-c	Wire Consumption Lbs/100' of Weld	Welding Speed in./min/pass	Argon Flow (cfh)	No. of Passes	Electrode Diam	Arc Volts	Wire Speed in./min
3/16"	170	4	24	50	1	3/64"	22	230
1/4"	200-250	8	24	60	1 or 2	1/16"	24-28	160
3/8"	240-300	16	24	60	2	1/16"	25-29	260
1/2"	250-320	30	17	60	2	3/32"	25-30	130

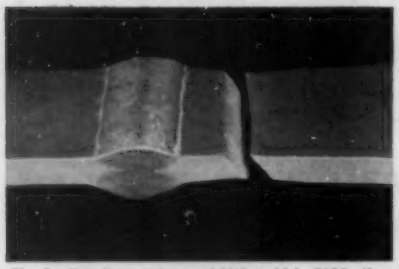


Fig. 2—Tensile specimen of MIG weld in 5086 alloy ¼" plate. Fracture occurred in parent metal at 40,000 psi with 15.7% elongation.

necessary to eliminate its effect. One method is to use a flux which dissolves and carries the oxide film away. In pressure and spot welding, the metal is cleaned so that the thin oxide film breaks up during welding. A third method of removing the oxide is by the action of the arc in the inert gas metal arc welding processes.

Thermal and electrical conductivity are also important in aluminum welding. Because aluminum alloys conduct heat and electricity much better than does steel, much higher currents must be used in resistance and arc welding them. Despite the low melting point of aluminum alloys, aluminum welding requires as much heat input as steel. Aluminum's high coefficient of thermal expansion accentuates internal stresses and warpage, which are also affected by the rate and amount of heat input. Consequently, high welding rates are more economical because expansion and distortion are minimized and less energy is lost.

Where structural strength requirements are high, porosity and crack sensitivity may be encountered. Welding processes and materials are now available for making welds that are consistently nonporous and crack-free. It is particularly important to use clean, dry sheet or plate, suitable filler metal, proper joint design and correct welding procedure.

Except in pressure welding, the welding operation results in fusion bonding two wrought or cast products with cast metal. It is important to recognize that weld metal is a casting and that filler metals must be selected which will combine with the parent metal to form strong, ductile weld deposits. Table III lists recommended filler metals.

TABLE III
RECOMMENDED FILLER ALLOYS FOR WELDING ALUMINUM ALLOYS

Base Plate	Filler Alloy Recommended
1100, 3003, 3004	1100
6061, 6063, 6066	4043, X5356, 5154
5052, 5254, 5086, 5083	X5356
2024	2024, X5356

Weldable Alloys

Practically all aluminum alloys can be welded by one of the above processes. Some alloys are more suitable for welding than others. Good welds can be made in the low strength non-heat treatable alloys (1100, 3003, 5005, 5052, 5050) with little or no difficulty. Alloys 6061 and 6063 are also widely used for making strong welded structures by any of the standard processes. Where post-weld heat treatment is possible, joint efficiencies approaching 100% can be obtained. Alloys such as 2024 and 7075 are used in spot welded products. Although arc welded applications of these alloys are rare, recent use of 2024 alloy in arc welded structures, with or without a post-weld heat treatment, indicates that this method of joining 2024 may be more widely used in the future.

The new non-heat treatable alloys (5083, 5086) are especially strong in the as-welded condition, and have excellent formability and corrosion resistance. These alloys offer an excellent combination of properties in highly stressed welded structures for which they are already being used.

Properties of Welded Joints

Heat applied in the welding operation melts the base plate and filler material in all the welding processes used for joining aluminum, except pressure welding. This heat also anneals the parent metal near the weld. A good general rule for calculating the strength of welded joints is to use the properties of the annealed base plate as design criteria. Some joints are stronger than the annealed parent metal, so that with sound welds and with the beads intact, tensile fractures occur at the fusion line or in the annealed zone adjacent to the weld bead. Table IV shows typical properties of welded joints and illustrates the advantage of using 5083 and 5086 where high strength in the as-welded condition is desired. This further shows the improvement which can be obtained in 6061 welded structures which are heat treated after welding to produce high yield strengths.

The use of sound, economical welded joints with good strength and corrosion characteristics is one of the many reasons for the growing use of aluminum in both new and improved products.

Further information concerning the welding of aluminum may be obtained from the Kaiser Aluminum sales office listed in your telephone directory or one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office:* Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois; *Executive Office:* Kaiser Bldg., 1924 Broadway, Oakland 12, California.

TABLE IV
COMPARISON OF TYPICAL MECHANICAL PROPERTIES OF TIG OR MIG WELDS IN ALUMINUM ALLOYS 5083, 5086, 6061, 5052 AND 2024
(Transverse Specimens, Weld Beads Not Machined Off)

Alloy and Temper	Filler Wire	Condition*	Tensile Strength psi	Yield Strength† psi	Elongation % in 2"
5083-H113	X5356	A.W.	42,500	22,000	12.0
5086-H112	X5356	A.W.	39,800	21,000	12.5
5052, 1/4H	4043, 5052, X5356	A.W.	28,000	14,000	15.0
6061-T6	4043	A.W.	30,000	21,000	8.5
6061-T6	X5356	A.W.	32,500	21,000	9.0
2024-T3	2024	A.W.	40,000	20,000	4.0
6061-T6	4043	H.T.	44,000	40,000	5.0
2024-T3	2024	H.T.	54,000	45,000	4.0

*A.W., as welded. H.T., solution heat treated and aged after welding. †At 0.2% offset.

Kaiser Aluminum

see our catalog in PRODUCT DESIGN FILE or write for copy

setting the pace—in growth, quality and service

Next time you're bearing comparing . . .

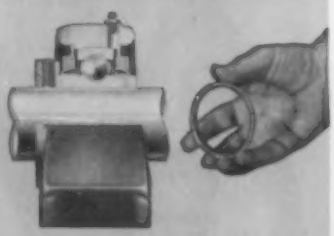
look for these

important differences

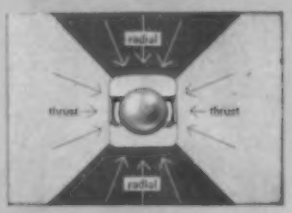
POSITIVE PROTECTION from moisture, dust and dirt is accomplished by seals extending from housing to inner ring. All aligning surfaces are enclosed in lubricant chamber.

Series 200 Ball Bearing Pillow Blocks are part of industry's most complete line of ball and roller bearing blocks.

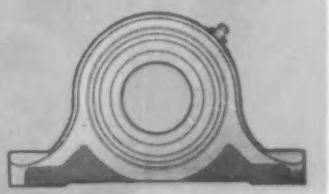
AUTOMATIC RELIEF OF EXCESS GREASE PRESSURE. Patented revolving inner seal members have escape holes enabling excess lubricant to pass out through opening around periphery of seal. No danger of seal being forced out . . . no chance for high pressure to damage bearing.



HIGHEST CAPACITY obtainable to carry heavy radial, thrust or combination loads is provided by single-row, deep-groove design.



GREATER STRENGTH. Base of block is cored to provide uniform metal thickness, assuring a sound casting, free from distortion.



They're all present only in LINK-BELT ball bearings

THESE important bearing differences show up in the performance of your equipment. For instance, a bearing may be subjected to shaft misalignment throughout its working life. Link-Belt's lubricated self-aligning feature assures free rolling . . . maintains maximum efficiency under any service condition. And Link-Belt alone offers that advantage in both ball and roller bearing blocks.

Whatever your bearing requirements, look to Link-Belt. All types and sizes of Link-Belt bearings are available from stock. Ask your Link-Belt office for Data Book 2550, containing complete information on the entire Link-Belt line.

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Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 12,714

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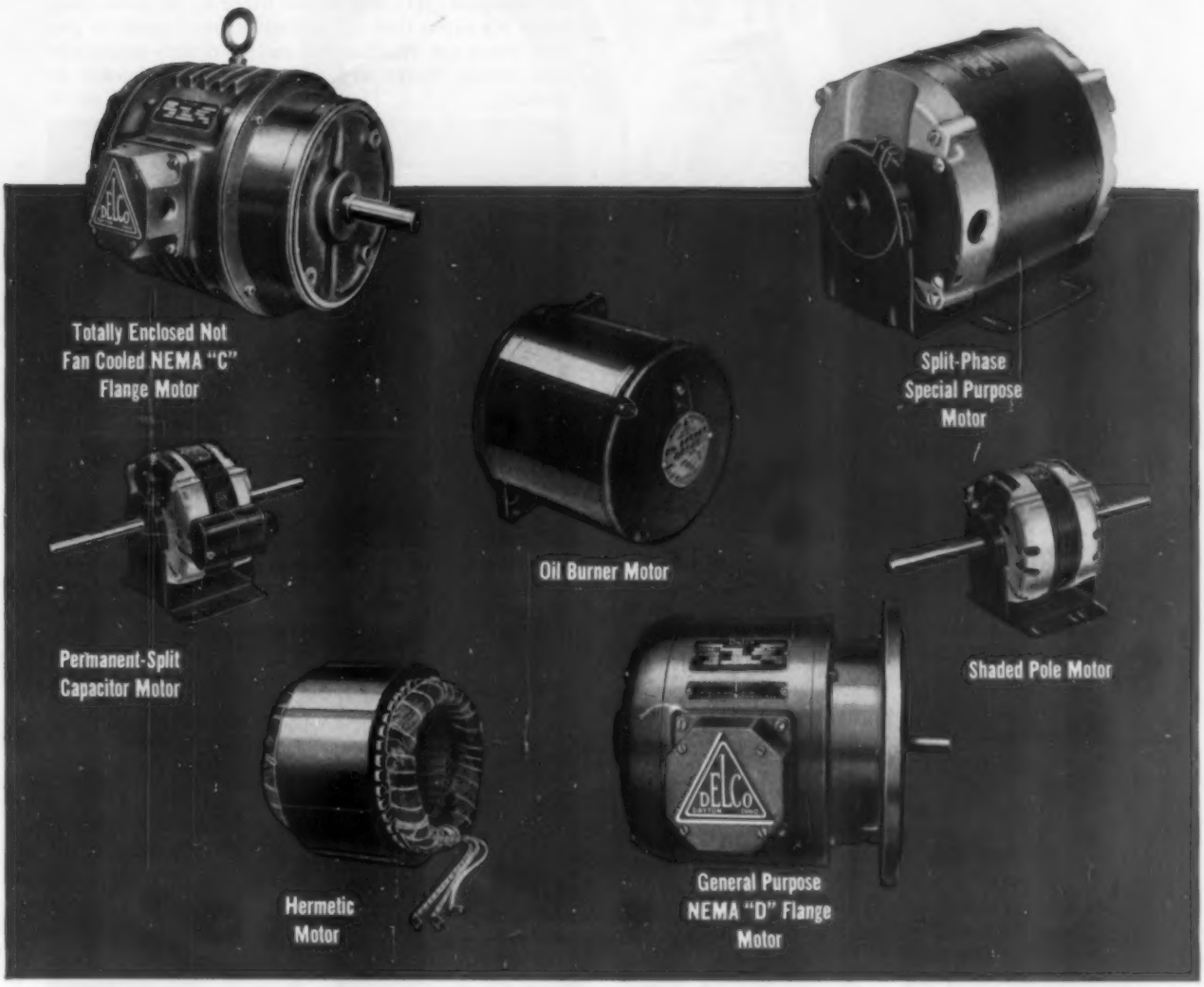
Experts at your service on DELCO "Job Fitted" Motors


Totally Enclosed Not Fan Cooled NEMA "C" Flange Motor
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Know the best electric motors, with the most to meet your needs . . . Delco job-fitted electric motors! Whatever your power requirements—for fractionals or integrals—there's a Delco motor for the job. Delco customers like Delco products—they like Delco fast delivery and service . . . they like Delco dependability!

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GM GENERAL MOTORS DELCO

DELCO *Electric* MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS, DAYTON, OHIO

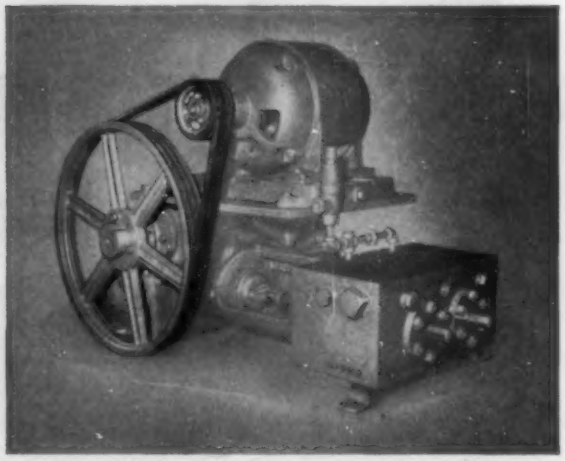
Proved best by Performance!

Why specify one sheave instead of another?

TAKE A CLOSE LOOK at this cutaway view of the Worthington QD — the *original* two-piece sheave. See how unique two-piece construction makes it easy to get on, easy to get off. But its heavy-duty split-tapered-cone hub grips shaft tightly, holds fast under the heaviest shock loads.

Some folks seem to think there's no difference between sheaves. No matter who makes them or sells them, a sheave's a sheave and a V-belt's a V-belt. Period.

Not our users, though. They know *our* sheave (the Worthington QD) *is* different. More to the point, they know it's *better* than other sheaves. And easier to get, too. There are Worthington service outlets practically everywhere. Never any delays in stock shipment or service! MV.5.4



SCIENTIFIC DESIGN of QD sheaves not only provides more efficient transmission of power but actually adds to the looks of your product. What's more, I-beam construction of the QD driveN sheaves provides greater strength with less weight.

WAREHOUSES LOCATED AT: Kearny, N.J. • Oil City, Pa. • Seattle San Francisco • Los Angeles • Denver • Tulsa • Ft. Worth • Houston New Orleans • Chicago • Cleveland • Atlanta, Ga.

PROMPT SHIPPING SERVICE. Thirteen factory warehouses with stocks covering over 100,000 V-belt drive stock combinations, from ½ to 600 horsepower, support over 250 stocking distributor outlets. These shipping centers can fill your requirements *fast*.

GOOD NEWS for engineers: This free, 100-page "Master Engineering Manual" makes sheave and V-belt selection as easy as falling off a drive shaft. Write for it today to Worthington Corporation, Mechanical Power Transmission Division, Section MV.5.4, Oil City, Pa.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

Wire machinery designers can you use a free assistant?

Designing a new wire fabricating machine is painful, hair-tearing work, and you probably would welcome all the help you can get.

For certain parts of the job, help is available from American Steel & Wire.

Consider the front end of the machine, where you actually load the wire. It pays to be sure that the machine will accept the most economical *standard* coils of wire.

We've found customers who have been ordering non-standard coils of wire for years, thinking all the while that they were standard. They had been paying a premium in price and time, due to the extra re-coiling time in the bundling room. And over the years, the wire handling facilities had grown so that it was a major operation to make use of standard coils of wire.

So when a new design is in the wind, call your American Steel & Wire representative and tell him what you are planning. He may think of something that will help.

USS AMERICAN MANUFACTURERS WIRE

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

USS TRADE MARK

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
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UNITED STATES STEEL

ORANGE ROLLER BUSHINGS

"carry heavy radial loads, with long life and low maintenance cost"

report KANE & ROACH, Inc., Syracuse, N. Y.

K & R No. OHLS 10 Stand Cold Roll Forming Machine shown below is used for cold roll forming of various shapes. An extremely accurate, rugged machine, it features outboard housings which are adjustable laterally of the base, to accommodate narrower but heavier materials when needed. The roll stands are also adjustable longitudinally of the base which permits the most efficient spacing of rolls for various shapes. Vertical adjustment of both the upper and lower roll shafts allows "downhill" feed.

Twenty Orange Roller Bushings are installed in the outboard roll shafts because of high radial capacity and freedom from trouble. Kane & Roach, Inc., have used Orange Roller Bearings in many of their machines since 1940.

Small space permits compact designing, with high load capacity

There are very good reasons for the outstanding performance of Orange Roller Bushings. They are made of finest bearing steel—hardened, ground and finished to the highest precision standards for durable, friction-free operation.

Exacting control of roller uniformity by electronic gauging, permits closer internal running clearances, minimizing possibility of misaligned rollers. Wherever a needle bearing is indicated, install Orange Roller Bushings for maximum protection.

• **Orange Roller Bushings are available in stock sizes from ½" to 8" shaft diameters. Stocks and engineering service in all industrial areas. Write for latest catalog.**

ORANGE ROLLER BEARING CO., INC., 551 Main Street, Orange, N. J.

MYLAR* gives Comptometer® a recording belt guaranteed for life!

MYLAR* offers you almost unlimited possibilities for developing new products . . . improving old ones

An outstanding feature of the new Comptometer® Dictation Machine shown above is the magnetic recording belt made with Du Pont "Mylar" polyester film. The manufacturer, Felt & Tarrant Mfg. Co., Chicago, Illinois, reports that the high strength of this amazing film makes possible an unconditional lifetime guarantee for its Erase-O-Matic belt—against wear, tear, heat, moisture and cold.

This successful product innovation is only one example of the way an imaginative industry is putting the unique potentials of Du Pont "Mylar" to profitable use. From metallic yarns to smaller transformers for guided missiles, Du Pont "Mylar" is making possible better products and lower costs in a wide variety of fields. Here's why:

"Mylar" has a tensile strength of 25,000 pounds per square inch, about one-third that of machine steel. It has a greater dielectric strength than almost any known insulating material, and an impact strength at least twice that of any known commercial film. What's more, Du Pont "Mylar" is resistant to moisture and solvents, and remains flexible and stable over a temperature range extending from -80°F. to 300°F.

Just a little creative research may show you where this versatile film can be used to *your* advantage. Mail coupon for a fact-filled booklet that tells you more about Du Pont "Mylar"—and the ways it may help you improve a product.

*"Mylar" is the registered Du Pont trademark for its brand of polyester film.

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Better Things for Better Living...*through Chemistry*

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 5-P, Nemours Bldg.
Wilmington 98, Del.

Please send me sample and further information on "Mylar" polyester film.

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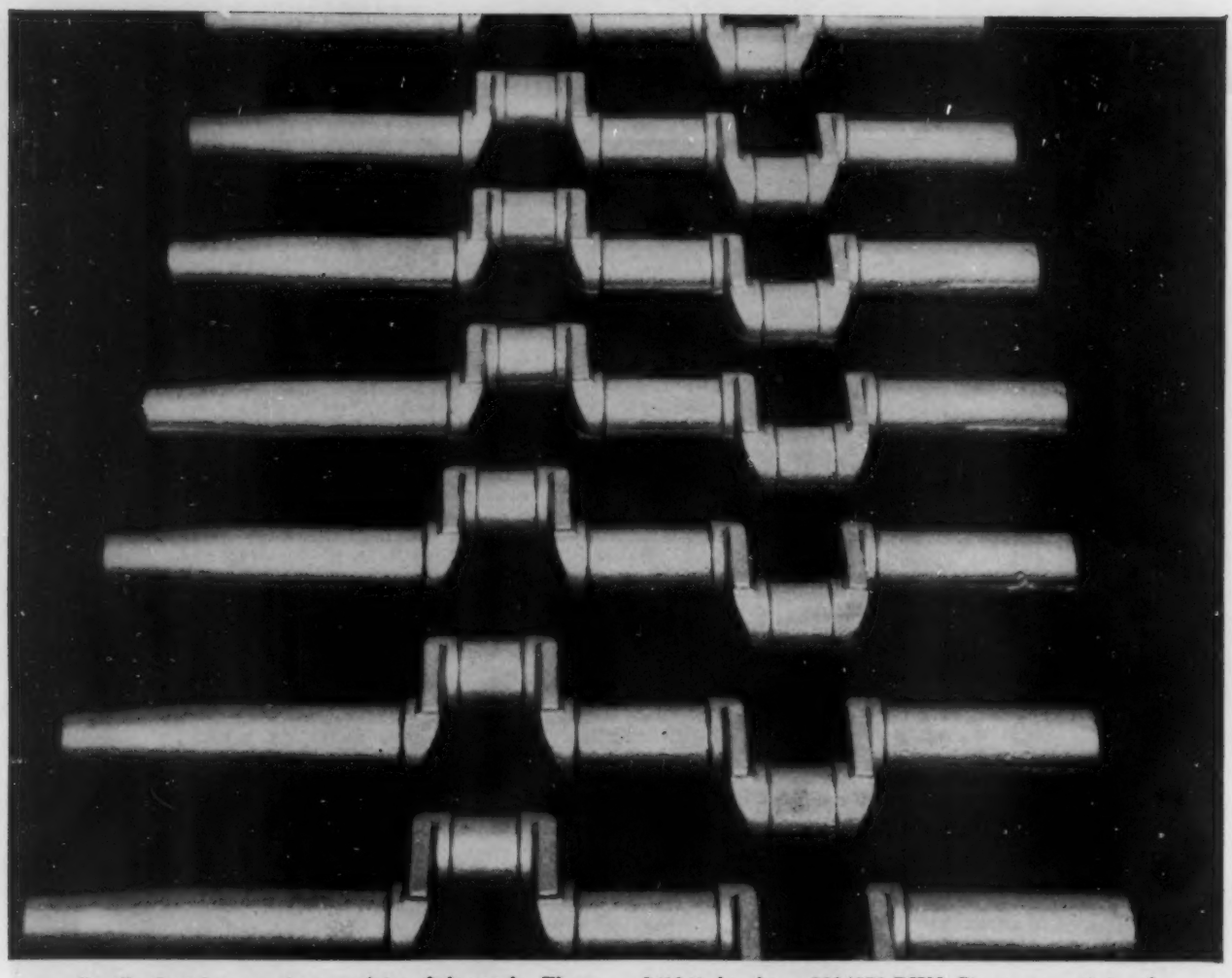


Ductile Cast Iron meets a variety of demands. These crankshafts utilize the 80-60-03 type, with the following typical range of properties: Tensile strength 90/110,000 psi, yield strength 60/75,000 psi, elongation 3/10%, hardness 200/270 BHN. Strong as-cast, tough and easily machinable. Also responds readily to flame or induction hardening. A carbidic, abrasion-resisting surface may be obtained by casting it against a chill.

Costs cut 70%... time cut 50% by switch to Ductile Cast Iron

OTACO LIMITED, makers of farm machinery at Orillia, Ontario, formerly used crankshafts of forged mild alloy steel for 2-cylinder gasoline engines.

By switching to crankshafts cast in Ductile Iron, this manufacturer cut down some 11 machining and heat-treating operations to a total of only 5 machine operations.

As a result, completed crankshafts went into assemblies at roughly 30% of the original dollars and cents cost. And production time . . . raw material to assembly point . . . decreased almost 50%.

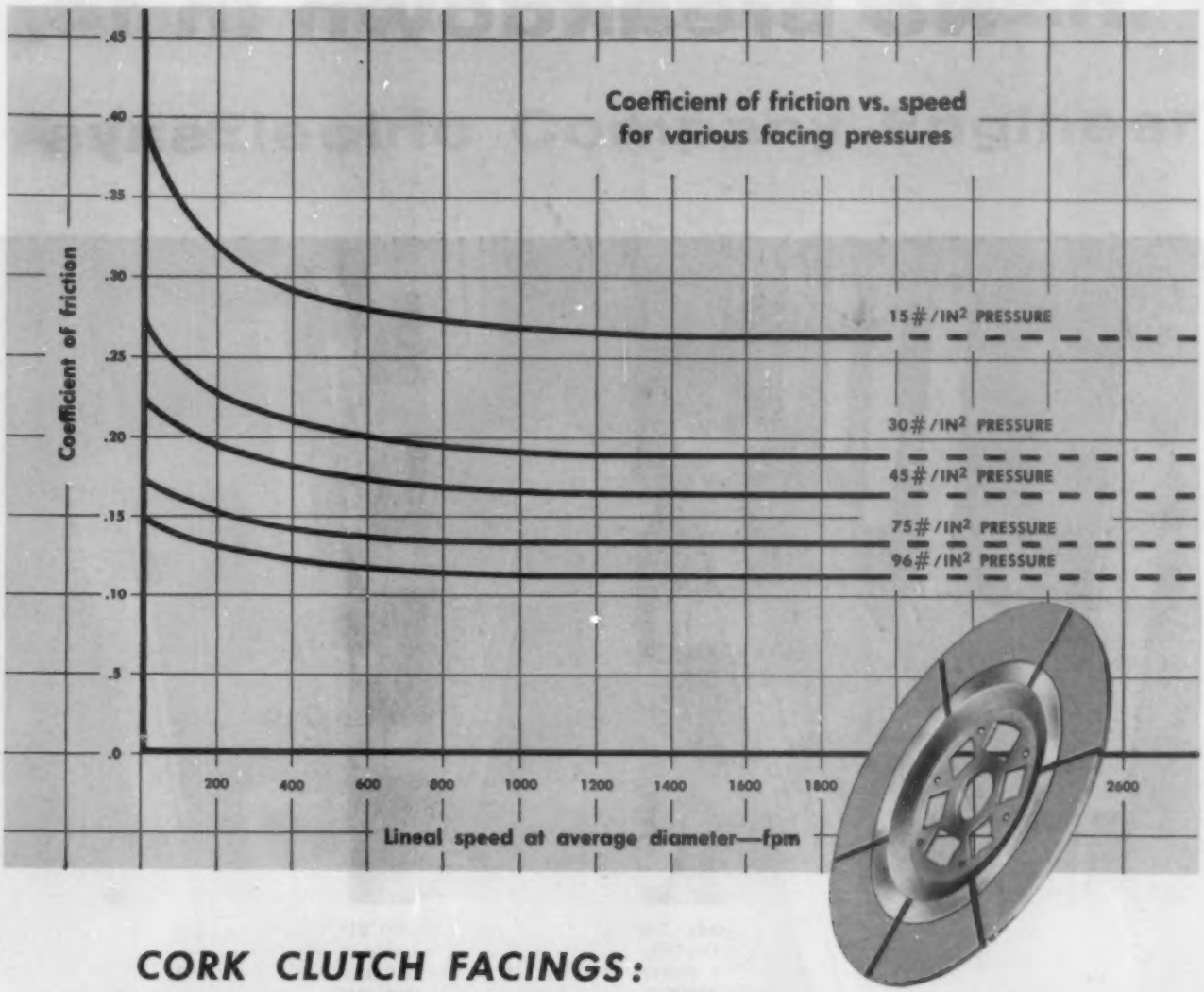
Savings, along with greatly improved performance, are provided by Ductile Cast Iron. Because it can be cast easily, like cast iron . . . yet it provides strength and toughness comparable to that of cast steel, and offers superior wear-resistance.

Perhaps you, too, can save money with this new engineering material. It's several times stronger than gray cast iron and up to 12 times tougher. Get the facts about this *greatest foundry advance in over a century.* Send for the new INCO booklet, "DUCTILE IRON, The Cast Iron THAT CAN BE BENT." Write for it now.

DUCTILE D IRON

ductile iron . . . the cast iron that can be twisted and bent

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.



CORK CLUTCH FACINGS:

High torque capacity at low engagement pressures

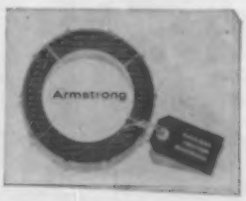
The curves above show how a typical cork-compounded clutch facing delivers high coefficients of friction under engagement pressures ranging from a low of 15 psi up to 96 psi.

The ability of cork to work efficiently at these low engagement pressures has helped many clutch manufacturers get high torque capacity at low cost—and eliminate wear and improve engagement. In automotive transmissions, for example, various cork plates are used under unit pressures of 20 psi to about 150 psi with excellent results.

Cork's versatility also enables designers to get just the engagement characteristics and torque capacity they need for specific applications. For example, the performance curves shown above can be varied—even reversed—by using unslotted plates, or by using waved plates. This flexibility gives designers wide freedom in clutch design which is of value whether their goal is cost reduction or performance improvement.

Perhaps the most surprising thing about cork is how long it lasts. As a matter of fact, Armstrong-compounded facings in the automatic transmissions of 13 American makes of automobiles normally outlast the cars themselves.

If you'd like to know more about cork facings, get in touch with Armstrong today. Write for your copy of our new 16-page illustrated booklet, "Resilient Friction Materials." Armstrong Cork Company, Industrial Division, 7210 Irvin Street, Lancaster, Pennsylvania.



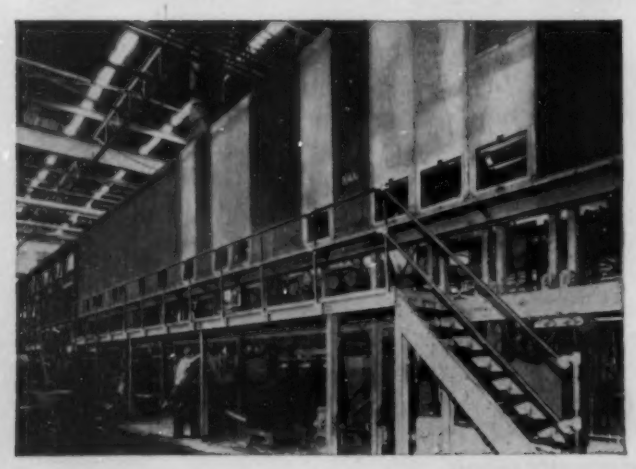
Armstrong FRICTION MATERIALS

. . . used wherever performance counts

"No breakdown in 14

says

Ajax Electric Salt Bath Furnace, interior view from end. Main roller chain drives lie parallel along furnace bed. Nine separate transfer chain drives (attached to visible sprockets) convey fixture carriers from bath to bath, each at a fixed speed which varies with each step.



(Left) Workman inspects processing baths beneath conveyor system of Ajax Electric Salt Bath Furnace. Nearly a half mile of roller chain drives keeps materials moving with clock-like precision through the various steps of the process.

"Morse gives us excellent results"

"We've worked with Morse Chains for 14 years, and have never experienced a breakdown of this product during that period. And, in our complex installations of electric salt bath furnaces, Morse is giving us excellent results."

Philip H. Atwood
Field Engineer
Ajax Electric Co.,

years with Morse Chain,"

Ajax Electric Company Engineer

Ajax Electric Salt Bath Furnaces point up how roller chain can save you on operating costs, cut your downtime, give you flexible, dependable power.

The Ajax Electric Co., Philadelphia, manufactures custom electric salt bath furnaces, used to temper metals used by the automotive and metalworking industries. These furnaces, which automatically transfer materials through as many as nine separate processes, use roller chain for power transmission.

Alkali cleaner, molten salt, steam—all are used in the process. Each is a potential threat to the more than 2000 feet of roller chain used in one of these Ajax furnace lines.

Operator hangs metal parts to be "martempered" in Ajax furnace line on fixture holder. Chain and sprockets in foreground point out ease of adjustment. By changing sprocket diameter, or addition or removal of links, timing of drive can be altered at any time.

Yet for 14 years, drives like these have performed efficiently and dependably, *with not a single breakdown.* (Read statement on left page.)

Morse Roller Chain instantly adaptable

Ajax furnaces involve timed "dips" of the metal parts to be hardened. These periods will vary. By simply changing the number of links in a chain drive, or the diameter of the sprockets, each step in the process can be speeded up or slowed.

You, too, can get the same type of superior power transmission with Morse Roller Chains. Precision-made in all standard sizes and pitches. A wide variety of standard and special-purpose attachments are available to meet specialized requirements.

Literature, engineering help FREE

Write today for Catalog C51-50, or free consultation on your power transmission problems. Morse has skilled engineers available to help you solve practically any problem involving transmission equipment: Roller Chain, Hy-Vo Chain, Silent Chain, Sprockets, Clutches, and Couplings.

Check these advantages of Morse equipment:

- √ Long service life
- √ Low operating cost
- √ Easy to assemble, disassemble
- √ Requires minimum maintenance
- √ Wide ranges of types and sizes
- √ Precision construction

MORSE CHAIN COMPANY • INDUSTRIAL SALES DIVISION • ITHACA, NEW YORK

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

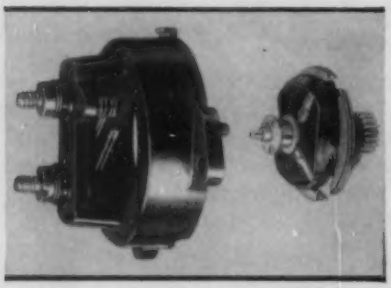
Carboloy Trends and Developments for Design Engineers...

- How sintered magnet solved clock motor problem
- How to design with carbides to resist impact

Sintering improves magnet's structural properties

The new Motochron automobile clock – the first to use a direct-current motor with a permanent-magnet stator – required a powerfully magnetic material with high physical strength.

The magnet had to provide uniform torque because the motor was sensitive to minute variations. Yet the magnet also had to be physically strong enough to withstand high pressures when it was molded into the motor's phenolic end cap.



Permanent magnet molded into phenolic end cap (left) provides bearing for armature, and supports brushes (right).

Carboloy magnet engineers came up with a design that not only fulfilled the requirements, but eliminated a costly grinding operation, as well.

Their answer was a ring-shaped magnet *sintered* – not cast – from Alnico 2.

Sintering is a technique of powder metallurgy, where finely powdered materials are compacted into shape and fused in an induction furnace. Sintering makes possible more complicated shapes and closer tolerances, increases structural properties tremendously, and provides very uniform magnetic properties.

In the case of the Motochron clock, the sintered magnet had a tensile strength of 65,000 psi – compared with 3,000 psi for cast Alnico 2. Its transverse modulus of rupture is 70,000 psi – compared with 7,200 for cast. The grinding operation was eliminated because standard tolerances on sintered magnets are much closer than on cast magnets.

If you are working on magnet applications involving thin sections, complex shapes, closer tolerances – where improved structural and magnetic properties are desirable–it will pay to look into Carboloy sintered magnets. For design information, write today, outlining your problem.

Carbides under compression withstand tremendous impact

Because cemented carbides approach the diamond in hardness, it's commonly believed that they are too brittle to withstand hard shocks. As a result, relatively few applications designed for impact or other heavy, transient loads utilize carbide's unique wearproofing properties.

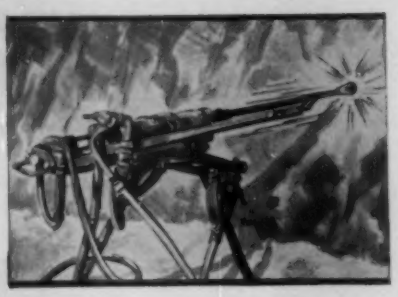
No one will claim that carbides are ductile. But they are far tougher than generally supposed. With properly designed supporting structures of adequate metallurgical characteristics, carbides can do jobs hitherto considered impossible or impractical . . . more efficiently and at less cost than steel or other materials.

The most spectacular demonstration of carbide's ability to withstand terrific punishment was at the recently completed Kitimat power project. Carbide-tipped percussive bits that Carboloy engineers helped design drilled nearly 2000 miles of blast holes at a fraction of the cost with steel bits.

Tunnel crews using these bits bored 10 miles through solid granite – breaking the world's hard-rock tunnel record 5 times in the process.

Carboloy cemented carbide bit inserts took 1200 to 2000 jarring impacts per minute, at 100 lbs. air pressure, from the pneumatic drills without cracking. They withstood the abrasive action of granite chips a hundred times longer than steel.

Design of these bits followed the basic rule for using carbides: *Keep them under compression.*



The ultimate limit of compression of Carboloy Grade 55-A, the most commonly used wearproofing grade, is about 610,000 psi–about 3½ times that of SAE 1095 heat-treated steel. By supporting the carbide properly and avoiding nonuniform loading, carbides can outperform other materials many times over.

Carboloy cemented carbides can be made with many combinations of structural properties. By increasing the cobalt binder content, they become more ductile, and therefore tougher. By decreasing the cobalt, they become harder and more rigid, with compressive strengths up to 1,000,000 psi. By adding titanium and tantalum carbides, still other physical characteristics result.

Carboloy cemented carbides can be produced in almost any size and shape. If you have a problem involving impact resistance, or other wear applications of carbides, write today for design assistance.

And for other applications, check into the design advantages of these Carboloy Created-Metals: *chrome carbides* for combating wear: *Thermistors* for detection, measurement, and control of minute temperature variations; *Hevimet* for high density and radioactive shielding applications; and *vacuum-melted metals.*

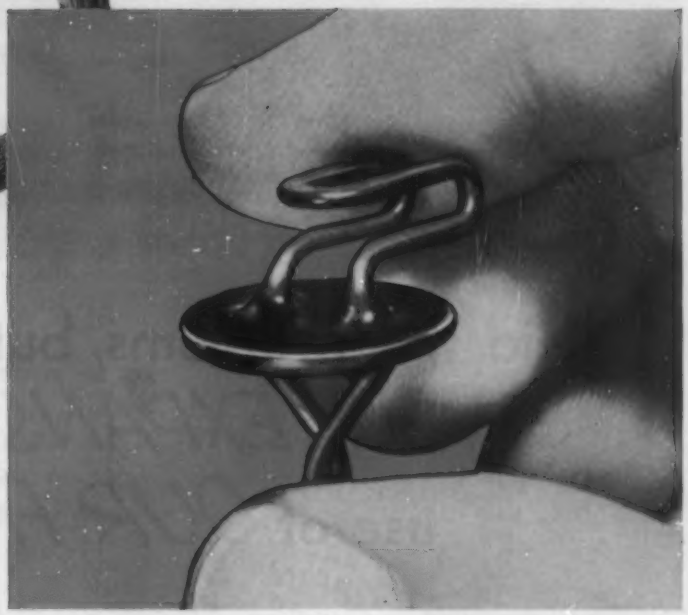
"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11127 E. 8 Mile Ave., Detroit 32, Michigan

CARBOLOY CREATED-METALS FOR INDUSTRIAL PROGRESS



For Electrical or Mechanical Improvements...

Data courtesy **Chemical Products Corporation,** East Providence, R. I.

PLASTISOLS SIMPLIFY PRODUCTION

One manufacturer wanted a tough, abrasion-resistant insulation that could be applied to motor coils quickly and economically. Another wanted an integrally molded gasket for auto door trim clips. Otherwise, rain leaked through the gasket holes, and applying a sealer took valuable production time.

Plastisols based on BAKELITE Brand Vinyl Dispersion Resins answered the needs of both. Plastisols can be used for coating, dipping, casting or slush molding. The coils were dip coated, the clip gaskets molded. Handled as a liquid, plastisols are formed with little or no pressure, and a short bake at moderate temperatures fuses them into a tough, resilient material.

Plastisols based on BAKELITE Vinyl Dispersion Resins are available in a wide range of colors. They also have good dielectric properties, as well as resistance to chemicals and water. Flexibility can be varied from semi-rigid to soft, depending on formulation.

Applications for plastisols based on BAKELITE Vinyl Dispersion Resins range from products as tiny as these clips, intricate as doll heads, large as industrial vent stacks. Find out how they can improve your product and production. Write Dept. KT-145.

BAKELITE
BRAND
Vinyl Dispersion Resins

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Five Large Fabricating Plants, and Rolling Mill, Located at Manitowoc and Two Rivers, Wisconsin
...Serving Industry Since 1895

Avoid the problems, but gain the profits of *PLANT EXPANSION* through use of *OUR FACILITIES*

ALUMINUM AND STAINLESS STEEL PARTS

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Here's how you can reap the profit of added production in a fast-moving market, *without* running the risk or facing the delay of increasing "plant and equipment." Your own receiving room can quickly become your end of a dependable pipeline supplying you with aluminum components from a massive production line that's already in business . . . and that has been for more than half a century!

Here, at Manitowoc, Wisconsin, we are equipped, staffed, and qualified to feed a steady flow of parts into your assembly line that will be as accurately made and dependably delivered as though they had come from your own plant. The pictures on these pages give you only a quick glimpse of the facilities that are at your disposal. A letter, wire or phone call will bring a trained consultant to you promptly, to talk over your particular needs, whether they be in design, production, or delivery. With a mutual understanding of the problems involved, we can then fit your new "plant and equipment" smoothly and profitably into your present organization.

CONTRACT DIVISION

ALUMINUM GOODS *Manufacturing Company*

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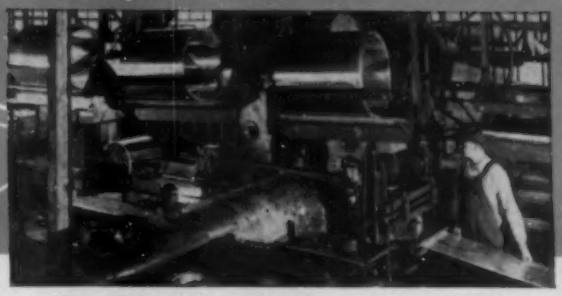
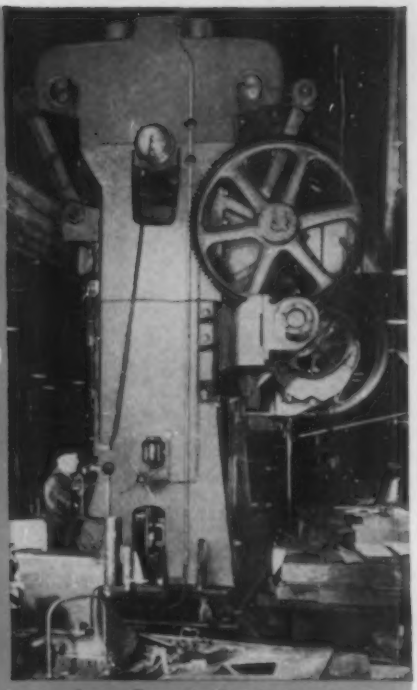
FIFTH AVENUE BLDG., NEW YORK 10 MERCHANDISE MART, CHICAGO 54

A Section of One of Our Three Modern Tool and Die Shops

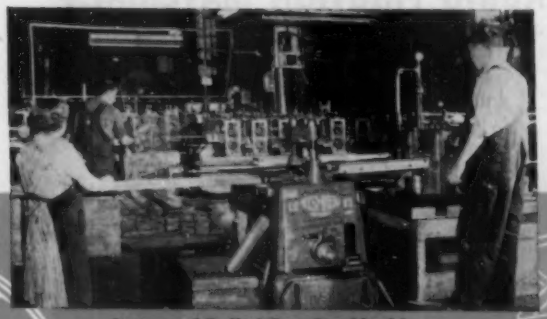


View of Coil Rolling Operation in Our Rolling Mill



Large Capacity Toggle Presses

To get **"THE BIG PICTURE"** of the men and machines waiting to serve you at Manitowoc, ask for your copy of our newest booklet, **"SERVICE TO INDUSTRY."** It will be sent you by return mail.

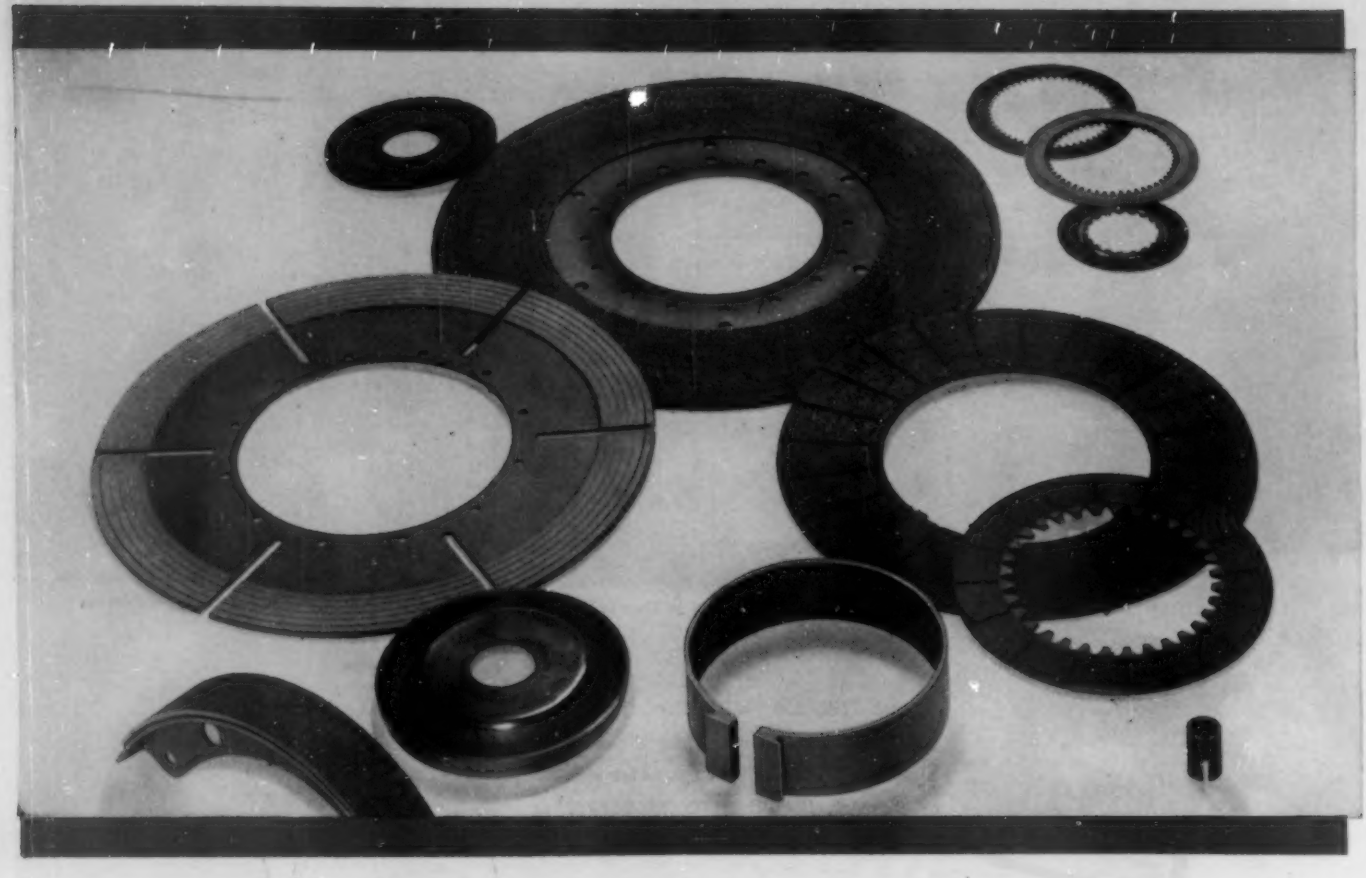


Battery of Rolled-Forming Machines

One of Several Resistance Welders

View of Conveyor in One of Our Spray Rooms, Showing Finished Work as it Starts Towards the Baking Ovens

CALL ON R/M ENGINEERING SERVICE



HOW R/M CAN HELP IN BONDING FRICTION MATERIALS

The bonding of friction materials to other mating members is an art. R/M has spent more years than any other company acquiring proficiency in it. Each successive job we've tackled has added to our knowledge of friction materials behavior. And trouble-shooting field trips—hundreds and hundreds of them—have familiarized R/M engineers with countless bonding problems. So the chances are good that if one is confronting you now, R/M has already solved it.

R/M can bond to almost any type material. Steel is most frequently used. But R/M can also bond to aluminum, phosphor bronze, and fibrous materials.

Unlike other manufacturers, R/M works with *all* kinds of friction materials—offers you the widest range in the industry. Consequently you can be sure of completely unbiased advice when you consult an R/M engineer.

If you feel that friction-parts performance could be improved in your equipment, contact Raybestos-Manhattan now. All the depth and breadth of R/M experience—the complete facilities of R/M's seven great plants with their research and testing laboratories—is as near as your telephone.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

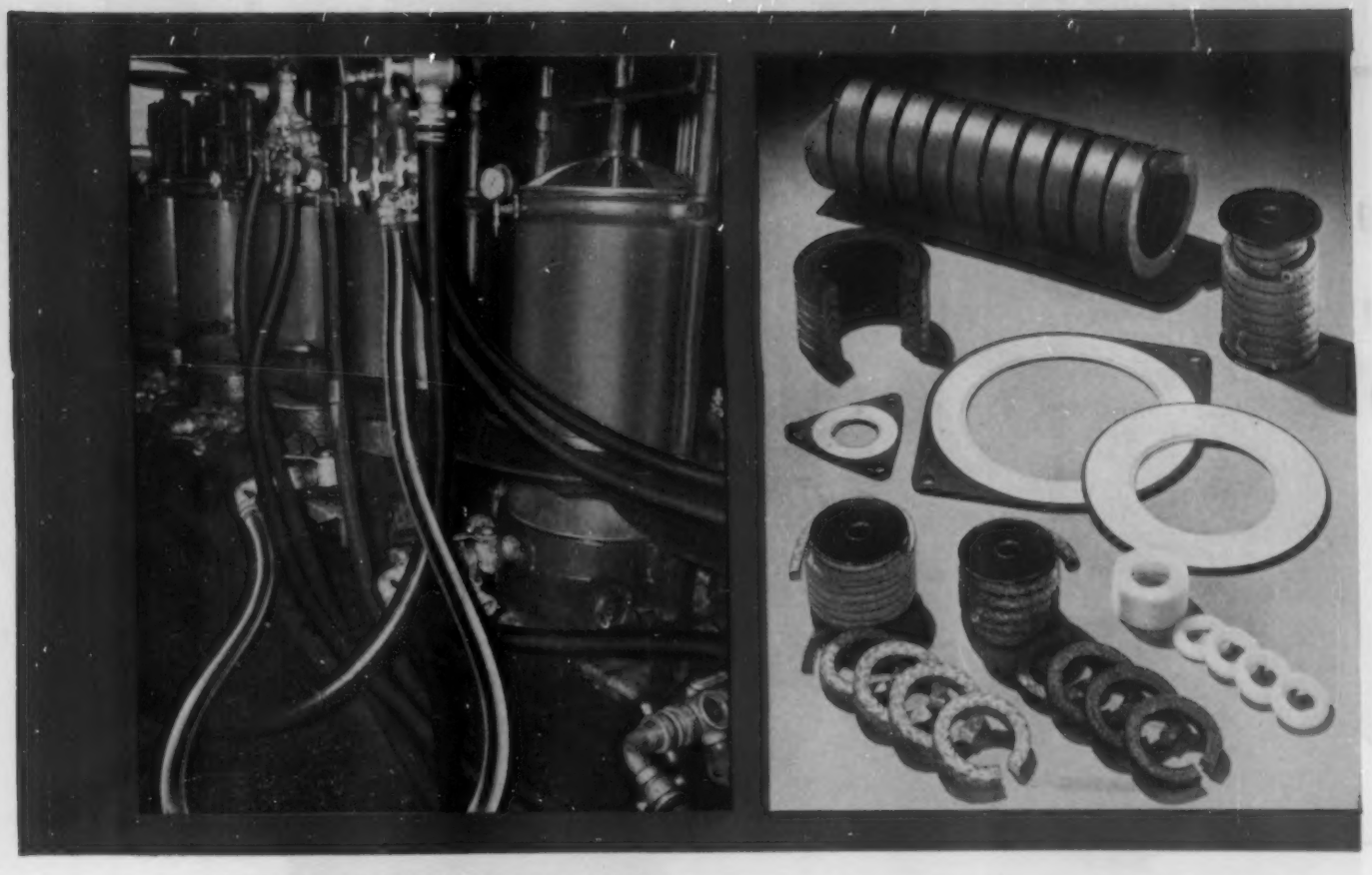
Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



ENGINEERED RUBBER HOSE

For general use with air, water, gases . . . special types for handling oil, acids, chemicals . . . non-spark high heat or non-contaminating constructions—R/M either has the hose or can make it for you. R/M hose constructions are made from natural or special synthetic rubbers—with strength members of long staple cotton . . . or super-strength synthetic cord . . . braided or solid wire reinforcement . . . always designed to provide maximum strength, plus flexibility without excess weight. R/M also makes flanged flexible pipe and rubber expansion joints. More than 60 years' manufacturing experience has gone into the development of R/M hose, V-belts, transmission and conveyor belts, and molded rubber products.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
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PACKINGS, GASKETS, Asbestos Textiles and "TEFLON"* products

If you have a packing problem, don't hesitate to call on R/M's specialized packing engineering service. R/M has the right type of engineered packing or gasket sheet, no matter what you are sealing: air, gas, water, steam, oil, solvents, foods or hydraulic fluids. Consult R/M also if your requirements call for asbestos textiles or "TEFLON" products. Take full advantage of R/M's many years of experience in all of these fields. Write for booklet on packings, gaskets and "TEFLON" products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION
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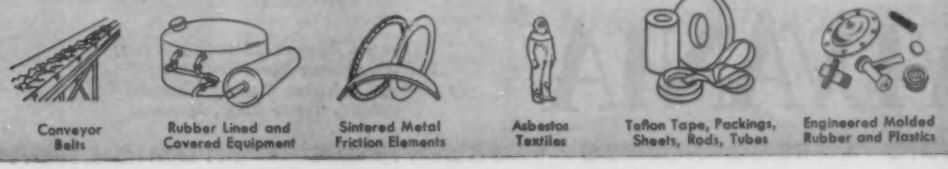
ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa. • Manheim 5-2211

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada


Conveyor Belts
Rubber Lined and Covered Equipment
Sintered Metal Friction Elements
Asbestos Textiles
Teflon Tape, Packings, Sheets, Rods, Tubes
Engineered Molded Rubber and Plastics

RM

—This is the Anscoflash Type I flash attachment

. . . The secret behind its compactness is this

plastic housing custom molded by Sylvania

THE Anscoflash Type I is a highly compact flash attachment offering the camera fan an economical entry into the field of "flash" picture taking.

To achieve this compactness and economy Ansco designed a unique plastic housing . . . one which would serve both as a reflector base and battery case.

All parts of the Anscoflash Type I are in some way fastened to this plastic housing. That made design of this part complicated and the important question where to get *complete follow through* on such a complex injection molding. Ansco found the answer at Sylvania. That's because Sylvania offers complete "one source" service in custom molding of both thermoplastic and thermosetting materials.

Here's the important point we want to make: However simple or complex your plastic parts, we'd like to make these same facilities available to you. They include an experienced design and engineering staff—expert mold makers—modern automatic molding equipment—metal stamping and forming—and complete assembly if your part requires metal inserts or additions.

Let us meet with you and discuss your next custom-molded plastic parts job. Phone or write Dept. K33S.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

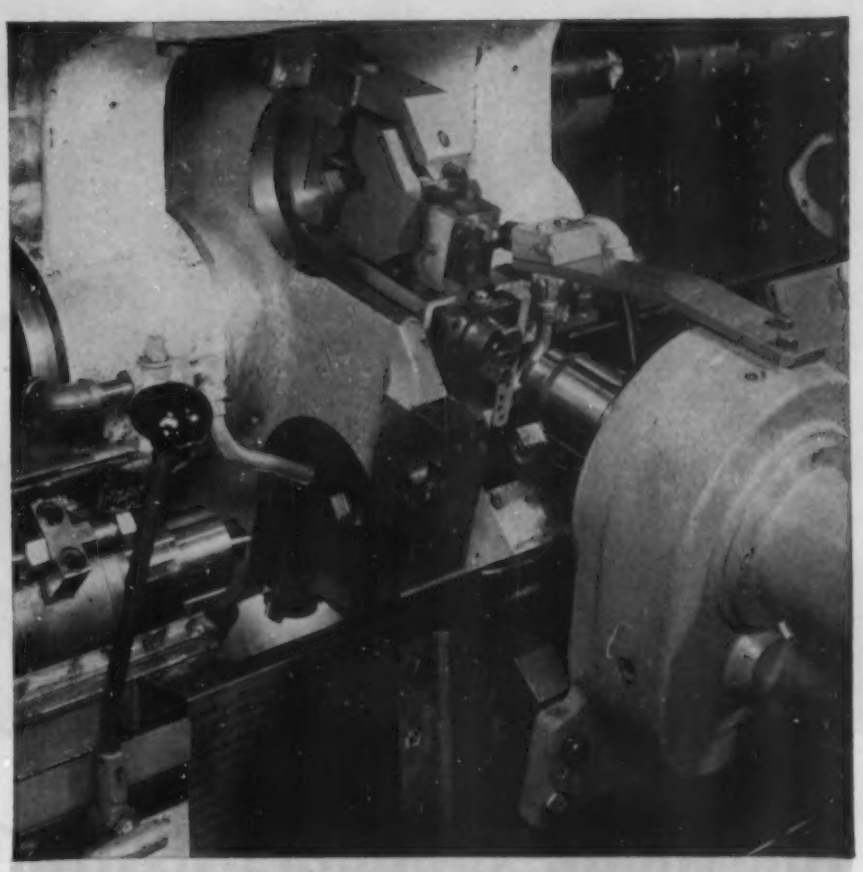
More precision — no more backlash after turret was mounted on TIMKEN® bearings

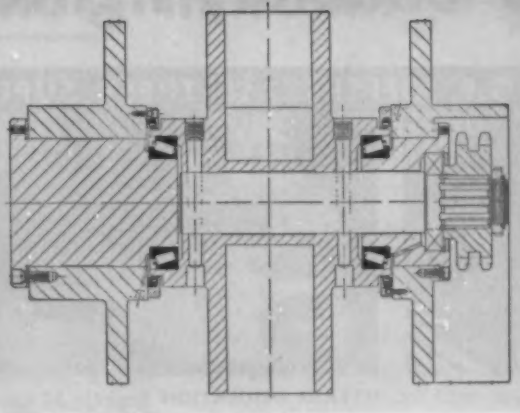
50 Timken® bearings are used in this Model 365 New Britain chucking machine, which can machine both ends of suitable castings or forgings simultaneously. The turret spindle of this machine was originally mounted on a plain bushing. This method did not eliminate backlash completely. When Timken tapered roller bearings were mounted at each end of the turret shaft, backlash was eliminated altogether, rejects cut. Timken bearings also prevent chatter and insure precision because they can be preloaded to any degree necessary to maintain the required rigidity.

Timken bearings can handle heavy loads because they carry them on the lines of contact between rollers and races. Their tapered construction permits them to take radial and thrust loads in any combination. Geometrically designed for true rolling motion and precision manufactured to live up to their design, Timken bearings practically eliminate friction.

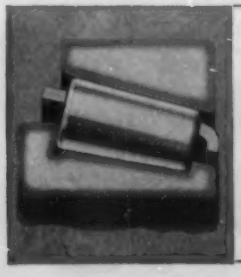
We even make our own special analysis nickel-rich steel to be sure Timken bearings are the best. We're the only U. S. bearing maker that does. When you buy or build machines, always specify Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





How **THE NEW BRITAIN MACHINE COMPANY** mounts the turret of its Model 365 Double-End Automatic Chucking Machine on Timken bearings to improve precision, minimize maintenance.



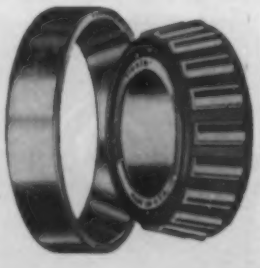
GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer. The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



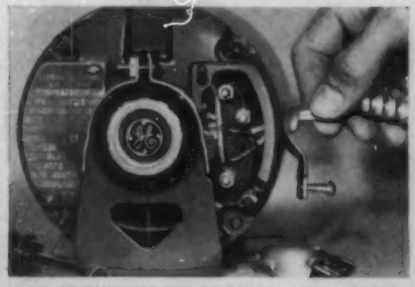
NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←

All these smaller, lighter G-E motors

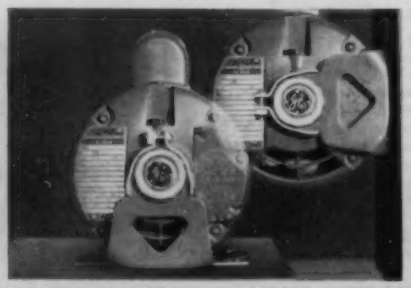
SMALLER, LIGHTER DESIGN—as much as 40% smaller and 50% lighter—speeds assembly and cuts product shipping weight.

MYLAR* INSULATION (right): 35 times the moisture resistance, 8 times the dielectric strength of paper insulation (left).

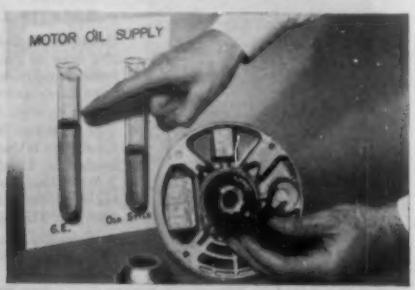
ALL-ANGLE OPERATION—lubrication is sure and protective when mounted in any position; no need for costly specials.



EASY CONNECTION—terminals are close to cover plate; speed-nut welded inside shell for fast connection from outside.



MOUNTING VERSATILITY—with resilient *or solid* cradle bases, you can rotate *any* G-E motor to meet your design needs.



DOUBLE LUBRICATION LIFE—50% more oil capacity and more efficient oil retention system cut G-E motor maintenance.

*DuPont trade-mark.

are available now in ratings you need

Act today to cut YOUR costs on material, assembly, shipping!

You have the opportunity to save *now* with smaller, lighter fractional-hp motors. General Electric, which pioneered these advanced motors three years ago, now offers prompt delivery on more than 850 *basic* models—including the right motors for *your* products.

IMPROVED PRODUCTS—plus savings in material, assembly, and shipping—await your conversion to these "years-ahead" G-E motors. For example: a compressor builder cut over-all manufacturing costs 25%. A pump manufacturer doubled sales of his streamlined product. A third manufacturer has reduced his shipping costs by 35%.

PROVED PERFORMANCE of smaller, lighter G-E motors on nearly 4,000,000 products demonstrates the superiority of the features listed at left.

TO HELP YOU realize *all* these benefits, G.E. offers application aid from engineers who have helped apply these advanced motors to all types of products.

WHY WAIT? Prompt delivery of the G-E motors you need can help you carry out a quality-boosting, cost-cutting program on your products without delay. For full information, including case histories of actual cost savings with G-E fhp motors, contact your G-E Apparatus Sales Office today. Or write Section 702-23, General Electric Co., Schenectady, N. Y.

Progress Is Our Most Important Product

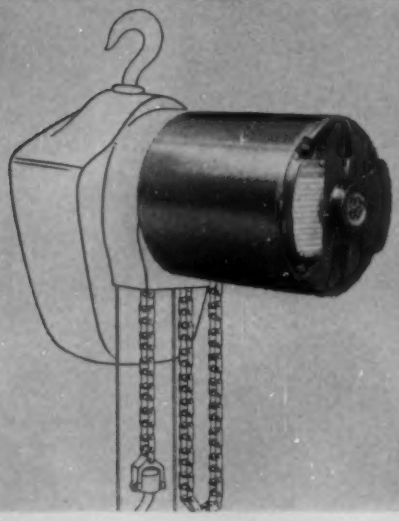
GENERAL ELECTRIC

ON NEXT PAGE
3 examples of G-E motor benefits in action

HOW SMALLER, LIGHTER G-E FHP MOTORS HELP

IMPROVE YOUR PRODUCT PERFORMANCE

ON MATERIAL-HANDLING EQUIPMENT



G-E BRAKE-MOTORS, ¼ to ¾ hp, provide positive braking or holding for overhead doors, small elevators, etc. Brake adjustment, usually unnecessary, is simple. Combined manual release and wear indicator is easy to operate, permits visual inspection. Bulletin GEC-1273.

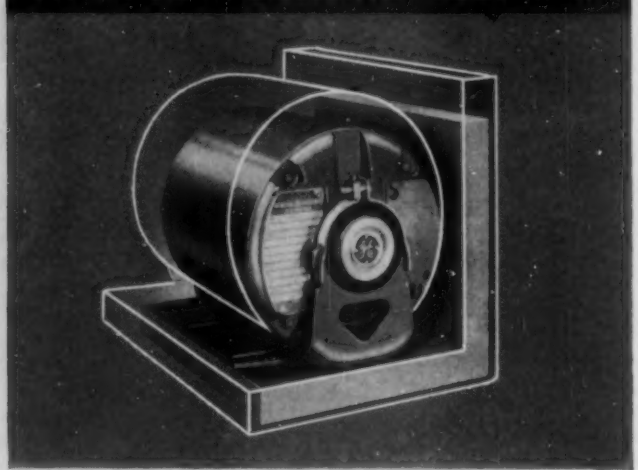
"PACKAGED" G-E GEAR-MOTORS for conveyors, hoists, etc., are the most compact low-speed drives available. Installation is fast and simple. Only maintenance normally required is infrequent lubrication. Concentric- or right-angle shaft, ¼ to ¾ hp. Bulletin GEA-6133.

THREE-QUARTER MOTORS save space, provide compact, lightweight power for "built-in" applications on cranes, hoists, etc. High-torque performance assures ability to easily start and run heavy loads. Single-phase motors available for instantly reversing operation. ¼ to ¾ hp.

ON ELECTRIC DOOR OPERATORS

50% LIGHTER WEIGHT of "years-ahead" G-E motors makes installation much easier. Valuable space is saved because of 40% smaller size. Doubled lubrication life minimizes maintenance in hard-to-reach places. Available for all types of doors and control systems. ⅙ to ¾ hp. See Bulletin GEA-5567.

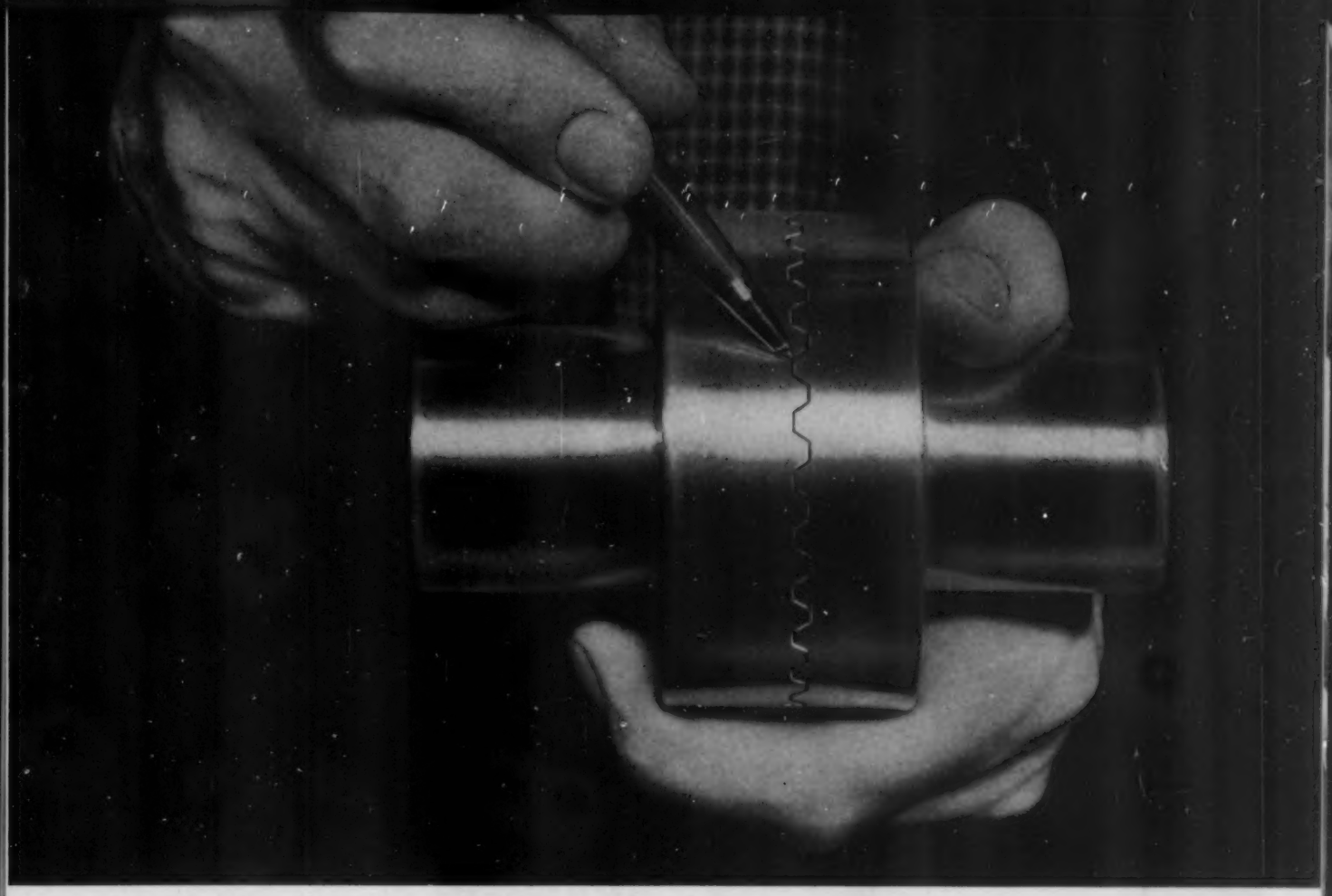
ON FOOD-PROCESSING EQUIPMENT



SMALLER SIZE of G-E motor helps you build a more compact, lighter-weight product. All-angle operation gives you greater design flexibility without special motors. Absence of high-pitch noise in the magnetic circuit means extra-quiet operation. Complete line ⅙ to ¾ hp. Bulletin GEA-5567.

FOR FULL INFORMATION on these and other G-E fhp motors, contact your nearby G-E Apparatus Sales Office. And write for Bulletins listed to General Electric Co., Sect. 702-23, Schenectady, N. Y.

GENERAL ELECTRIC



This photograph shows tooth contact of a Curvic Coupling used in an aircraft drive shaft. The coupling simplifies the manufacture and assembly of this shaft and permits "in the field" maintenance.

CURVIC® COUPLINGS—*what they are and how they can help improve your product*

Curvic Couplings are precise face splines that drive, center and align parts with a high degree of accuracy.

They can improve your product by giving improved design, simplify maintenance through the use of interchangeable parts and lower production costs by eliminating the need for large complex parts.

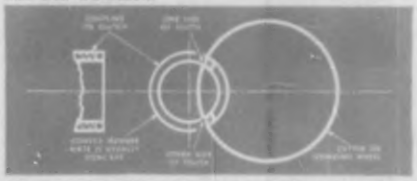
Because Curvic Coupling teeth curve lengthwise—either concave or convex—contact between the joining teeth is controlled. The load carried is equally distributed on all teeth as tooth-to-tooth spacing is held to extremely close limits. Therefore, Curvic Couplings can be made smaller, thinner and lighter than many other types of toothed connections.

Three principal types

1. *The permanent Curvic Coupling* is used for driving *and* aligning. It is for such uses as building up accurately balanced, precision rotors for jet aircraft engines. Curvic Couplings can hold mating parts within 0.0005" total runout.
2. *The semi-universal Curvic Coupling* allows misalignment of shafts (2° maximum) together with axial freedom. Localized tooth bearing prevents load concentration on ends of teeth.
3. *Shift and overload Curvic Clutches* maintain proper tooth contact while the clutch engages and disengages. Shift clutches are used in washing machine wringer drives, motor trucks, outboard motors, aircraft —wherever a positive toothed clutch is needed.

Overload clutches are used where the amount of torque to be transmitted must be regulated, as in power screwdrivers.

The Gleason Engineering Department will be glad to consult with you regarding Curvic Couplings for your product. Write for our booklet.



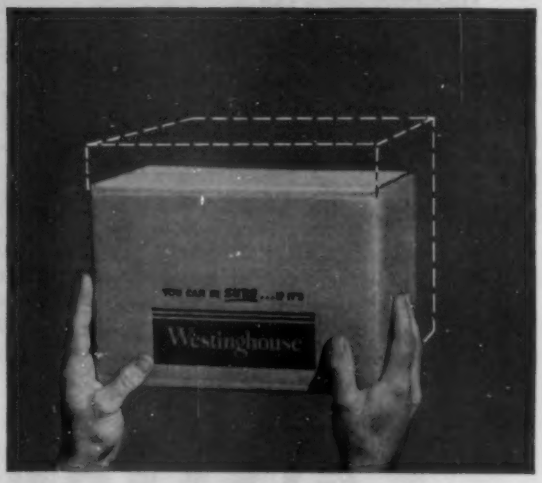
The drawing above shows the method of producing both sides of Curvic Coupling teeth with the same surface of the cutter or grinding wheel, so that both sides have the same curvature. Curving the teeth lengthwise in this manner assures control of contact between joining teeth.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

ACTUAL PHOTOGRAPH



Fact 2 . . . up to 40% less space needed to stock. These new motors take less room in your product, too, because they are more compact in design.

New Westinghouse Design Cuts Motor Weight Up to 50%

. . . one important FACT about the new Westinghouse 48-frame fhp motor

Many cost-saving features make the new Westinghouse 48-frame your *best* motor buy. Lighter, smaller and more compact in design, it can be used to advantage in your product.

The lighter motor lets you use lighter mountings, lowering material costs. And it's easier to handle, faster to install on assembly lines. In many cases, your shipping costs will be lowered, too.

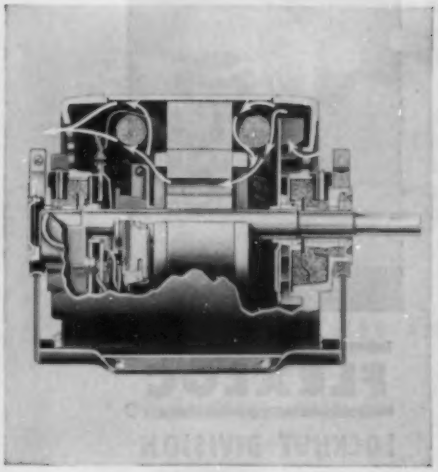
A new, lighter base—either rigid welded to frame or resilient—assures stronger mounting even under severe operating conditions.

It is the only true all-angle mounting motor. Don't expect all these benefits in any other motor.

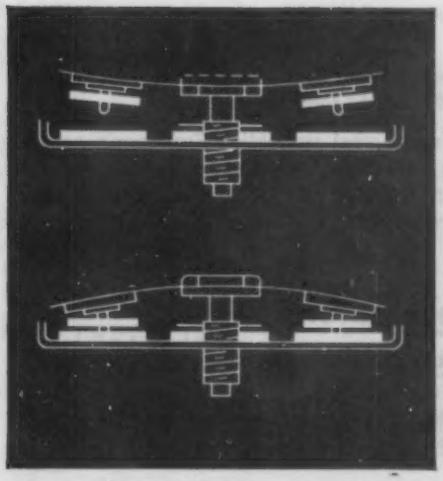
The Man With The Facts, your Westinghouse sales engineer, has all the information about this new fhp motor line. Contact him or write for DB-2801 for complete technical data. Westinghouse Electric Corporation, Small Motor Division, Lima, Ohio. J-03019

YOU CAN BE SURE...IF IT'S

Westinghouse



Fact 3 . . . straight-through ventilation of this new motor insures cooler operation for longer running periods, even at peak loads.

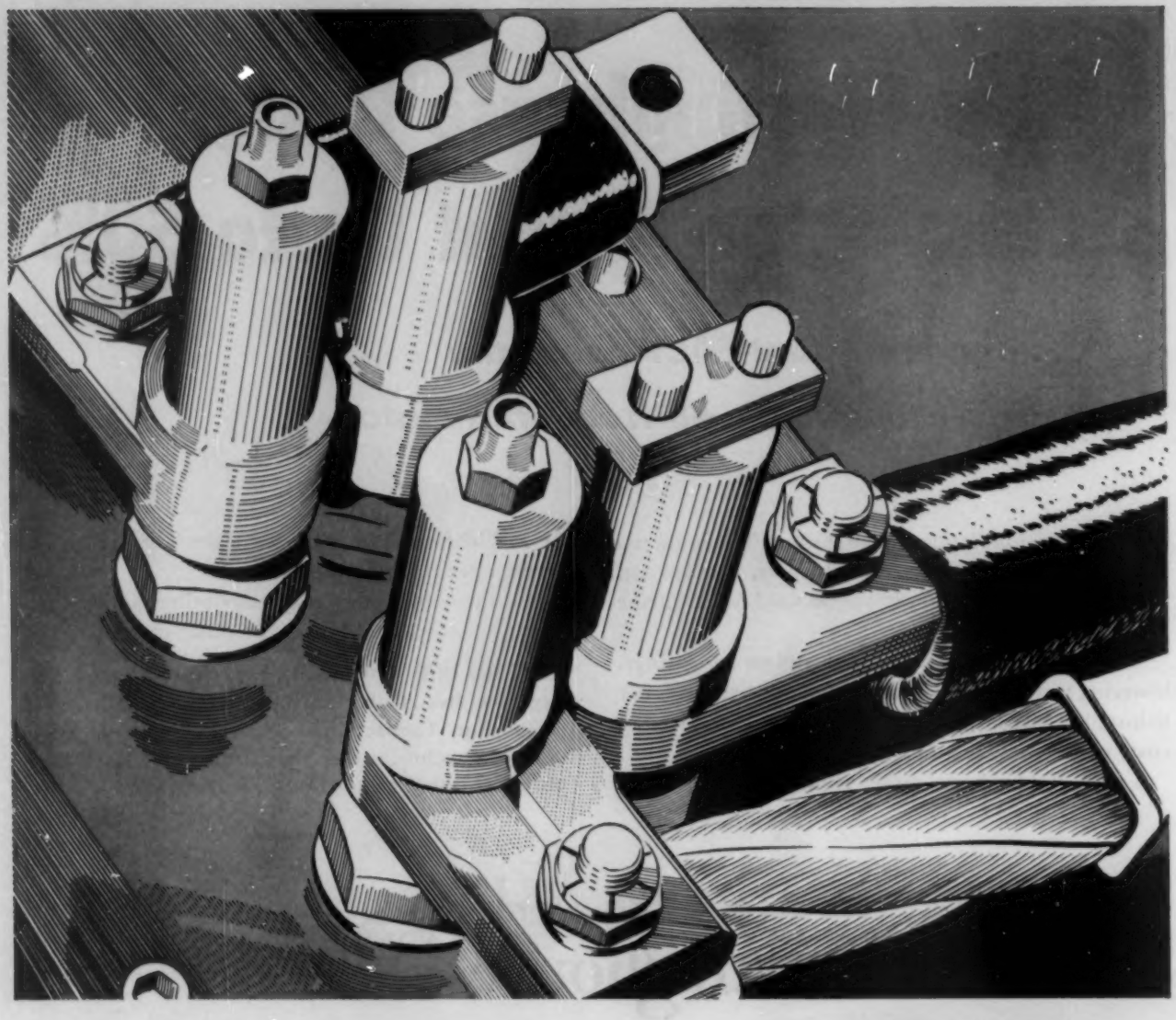


Fact 4 . . . exclusive Thermoguard® overload protection (optional). It opens (top) when overheating occurs . . . it resets when cool to resume operation.

Fact 5 . . . Mylar® insulation, one half as thick but possessing greater dielectric strength, provides better moisture protection, greater physical strength.

®DuPont Reg. Trade-Mark

FLEXLOC AT WORK



DESIGNER OF WELDING DIE uses one-piece, all-metal thin FLEXLOCS as stop nuts on flexible cable assembly. Although the assembly swivels, FLEXLOCS won't work loose.

Nuts that loosen cause trouble. Contact is poor; flow of current erratic; welding faulty—and faulty welding means inferior finished jobs.

Don't take any chance of nuts loosening on vital assemblies. FLEXLOCS are made to stay put. And they are available in a wide range of sizes, types and material. See your authorized industrial distributor for Bulletin 866 and samples. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

• • •

Use FLEXLOCs anywhere safely

ON ROUGH BOLTS. They'll smooth out bolt threads without damaging the threads of the nut.

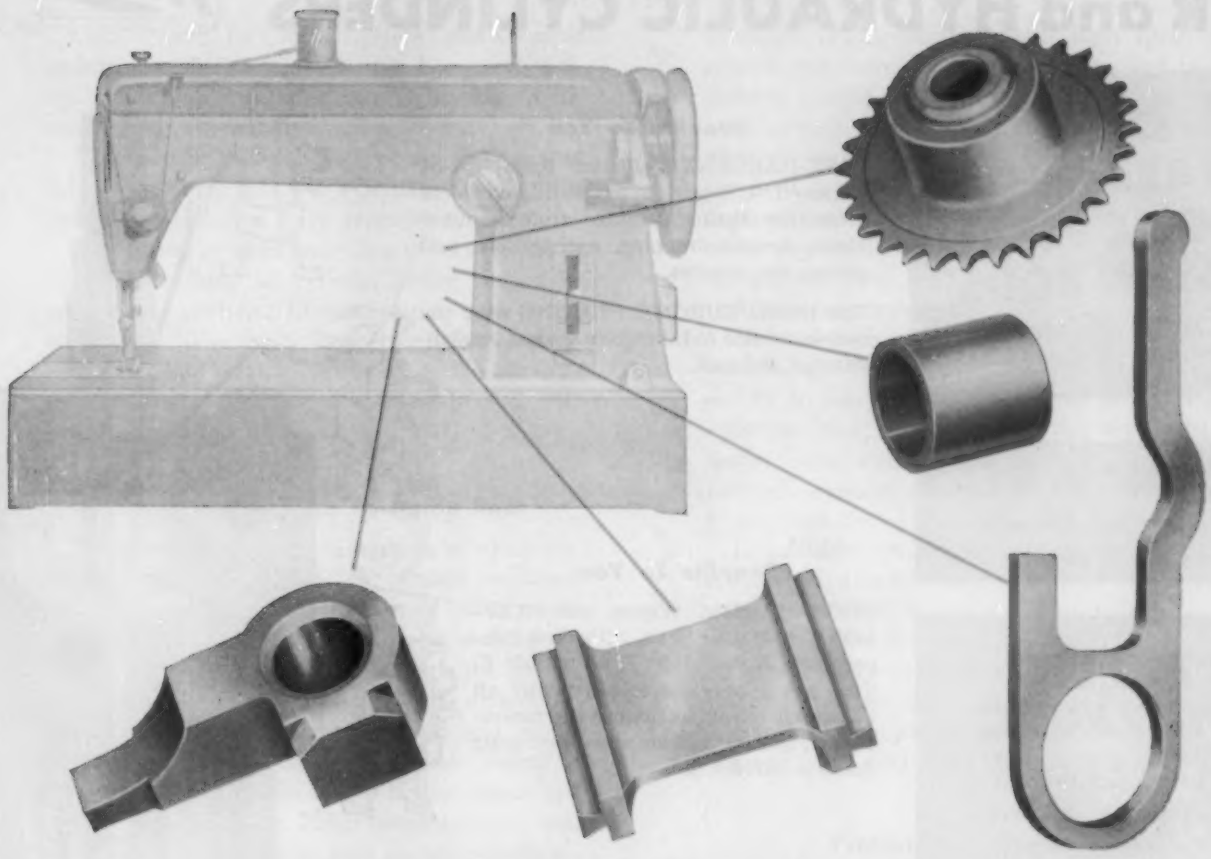
IN TEMPERATURES TO 550°F in plated nuts and even higher in unplated ones. High temperatures do not affect FLEXLOCS. Nuts with non-metallic inserts fail under such conditions.

AS STOP OR LOCK NUTS. After at least 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC stays put.

REGARDLESS OF MOISTURE, OIL, DIRT OR GRIT. None of these conditions make any difference to a FLEXLOC, and vibration won't loosen it.

FLEXLOC®
LOCKNUT DIVISION
SPS
JENKINTOWN PENNSYLVANIA

IN. POWDER METALLURGY . . . IT'S AMPLEX



Switching to OILITE® helps Make this Manufacturer Competitive

Price competition and rising production costs caused one sewing machine manufacturer to re-examine his component parts to determine how costs could be lowered while maintaining high quality standards.

Super OILITE and Steel OILITE provided the answer. Many parts, including gears, eccentrics and sprockets, were redesigned for production in these high-strength materials. Formed in automatic presses in seconds, these OILITE parts reduced costs substantially by eliminating costly machining operations . . . and high quality is maintained.

The conversion provided another benefit. Certain parts were designed to take advantage of the self-lubricating qualities available in some OILITE materials.

Let Amplex help you with your parts problems. The Chrysler-Amplex engineering facilities, unmatched in the powder metal industry, are ready to serve you. Call or write today.

CHRYSLER AMPLEX PRODUCTS

OILITE Bearings	Finished Machine Parts
Permanent Metal Filters	Friction Units

IT'S NEW! IT'S FREE!

First complete information on powder metal bearings, finished machine parts, filters and special parts. 48 pgs. Write today for OILITE Engineering Manual E-55.

OILITE — *Only Chrysler makes OILITE*

CHRYSLER CORPORATION • AMPLEX DIVISION

Dept. F-10 Detroit 31, Michigan • Overseas Distribution—Chrysler Export

Four More Miller Firsts . . .

Our "Report To Cylinder Users" was a simple statement of Miller Fluid Power Company's policy. In it was mentioned our dedication to the constant improvement of our products.

In line with this policy, here are new quality cylinder features that will eliminate many of the problems which you have reported to us.

Miller gave cylinder users one of its firsts when we chrome-plated all cylinder piston rods. Our reason was obvious. Chrome-plating gave every rod a mirror-like finish that no corrosive or abrasive dust could scratch. Miller made this chrome-plated, longer lasting rod standard. AT NO EXTRA COST.

Preventing Damage To Piston Rods

There were still plenty of hazards to which piston rods were subjected. A careless workman with a too handy wrench or pair of pliers meant a scored piston rod. A falling object striking the rod dented the softer metal beneath the plating of chrome. A jolt during assembly left its trouble-breeding mark. All of these nicked and scored the piston rods, damaging the whole assembly. Little could be done about this beyond repair and replacement until the Miller announcement that from now on the piston rods on all cylinders—air and hydraulic—will be specially hardened (52-55 Rockwell C) to foil the carelessly used tool, the accident in transit or assembly, the falling object or unnoticed knock. Naturally, the new hardened rods will still be chrome-plated. Miller will now make this super quality an everyday standard. AT NO EXTRA COST.

Meeting The Challenge Of The New Demands On Seals

Rod seals on Miller hydraulic cylinders were constructed to be leakproof under all ordinary operating conditions. We guaranteed this. But we also stated in all our catalogues that for special conditions there must be special rod seals at an extra cost. Rod seals to withstand high temperatures had to be specially constructed. Where fire resistant fluids were used, special rod seals had to be provided at an extra cost. Because many fire resistant fluids destroy ordinary packing.

The present widespread use of these fluids and excessive heat generation from high speed operation and increased loads have resulted in reports of trouble on cylinders where ordinary seals were subjected to these hazards. These reports were not received with joy at Miller, even when the fault was definitly not ours. We don't like to have trouble develop on any Miller installation under any condition. So we decided to do something about these problems of the rod seals.

A new expensive material known as "TEFLON" has been developed for use as seals. This material is impervious to temperatures from —100° to plus 500° F. It resists all known fluids, even the most destructive of the fire resistant fluids. Now, every piston rod on every Miller hydraulic cylinder will be fitted with "TEFLON" Piston Rod Seals. AT NO EXTRA COST.

In addition, all rod wiper seals on all Miller Air and Hydraulic cylinders will be of the same chemical-and-heat resisting Teflon material.

These Teflon rod wiper seals will be standard on every Miller cylinder, regardless of how and where it will be used. This is Miller's way of doubly insuring cylinder users against all possible hazards. AT NO EXTRA COST.

Protection Against Rust

The barrels of Miller air cylinders are of moisture-resistant brass. The barrels of hydraulic cylinders, since they run in oil, are protected once they are installed and in operation. Beyond this all cylinder parts are subject to rust and corrosion. Such exposed parts as heads, caps and tie rods quickly show the unsightly evidences of rust. At least this has been so up till now. But all this is now being corrected.

From now on Miller will protect all these parts on both air and hydraulic cylinders with a black oxide process in which a chemically created ferric oxide coating is developed on the surface of the metal to protect against rust and other corrosion. Every Miller cylinder sold will carry this added protection. AT NO EXTRA COST.

These four new Miller firsts are added to the many firsts established by Miller. Like other Miller firsts which created new departures in cylinder design and construction, these are now offered as Miller standard specifications. AT NO EXTRA COST.

MILLER FLUID POWER COMPANY

2002-04 N. Hawthorne Avenue

Melrose Park Illinois

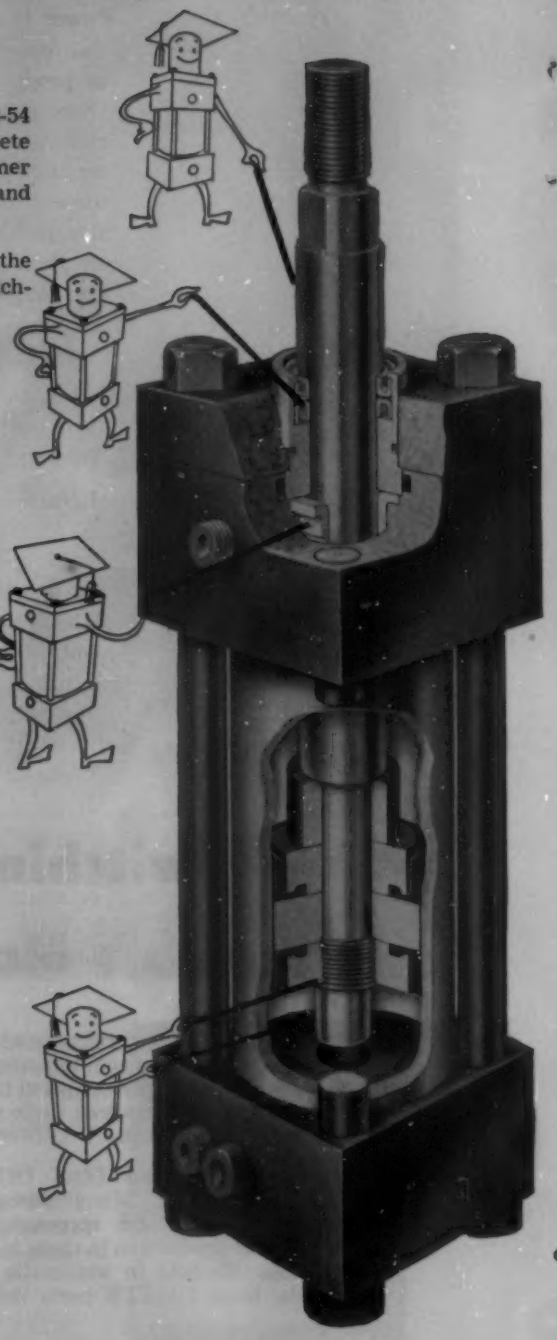
at no extra cost to you . . .
NEW Quality Features on All AIR and HYDRAULIC CYLINDERS

CASE HARDENED CHROME PLATED PISTON RODS
On all Miller Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences.

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust.



"TEFLON" WIPERS
On all Miller Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Seals withstand temperatures from —100° F. up to 500° F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use.

"TEFLON" HYDRAULIC ROD SEALS
On all Miller Hydraulic Cylinders only

RUST RESISTANT SURFACES
On all Miller Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, and the unplated portions of the piston rods have this finish. It is not recommended for water service.

WRITE FOR CYLINDER BULLETINS H-104 and A-105

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

Over 8,000 Different Cylinder Selections Available for Immediate Delivery. Write for Complete List.

EFFECTIVE DATES

These new Miller features will be provided at no extra cost after January 1, 1956—and at Miller's option prior to that date.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY BUFFALO • ROCHESTER • MINNEAPOLIS • GRAND RAPIDS • DETROIT • FLINT FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • ATLANTA TORONTO, CANADA and OTHER AREAS

MILLER FLUID POWER CO.

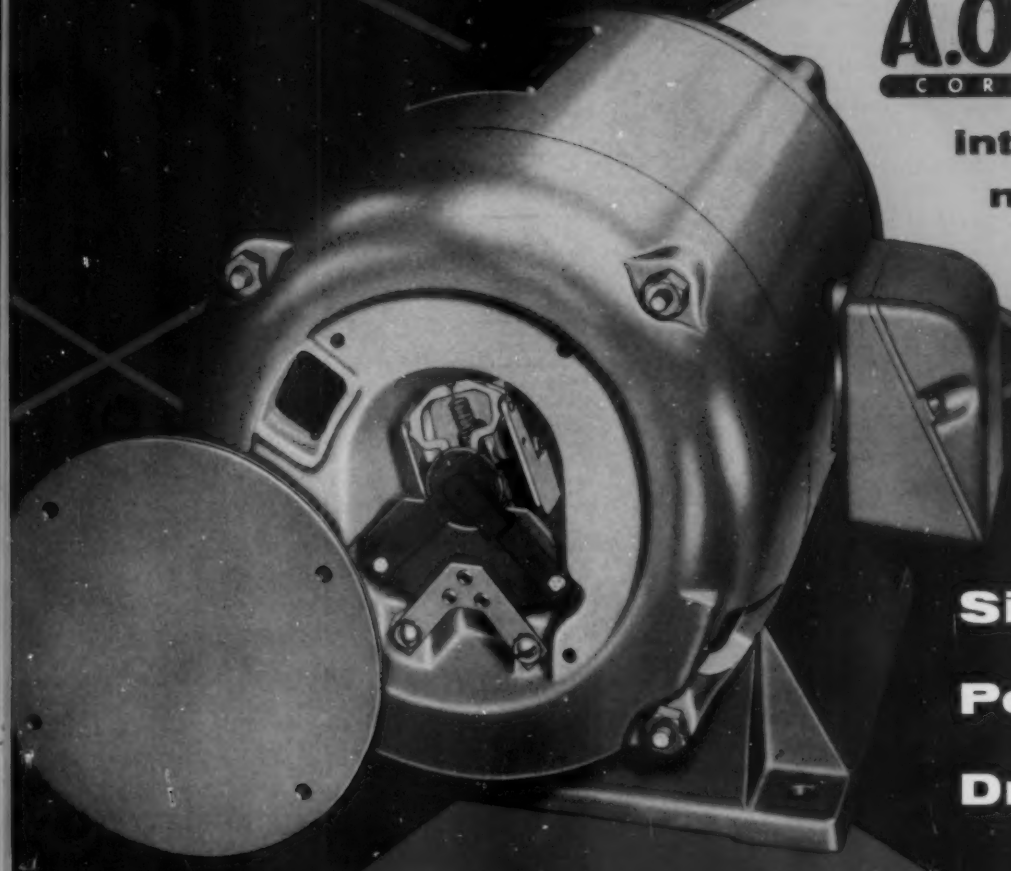
2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS • COUNTERBALANCE CYLINDERS

Enjoy performance
that's
application-engineered

Depend on

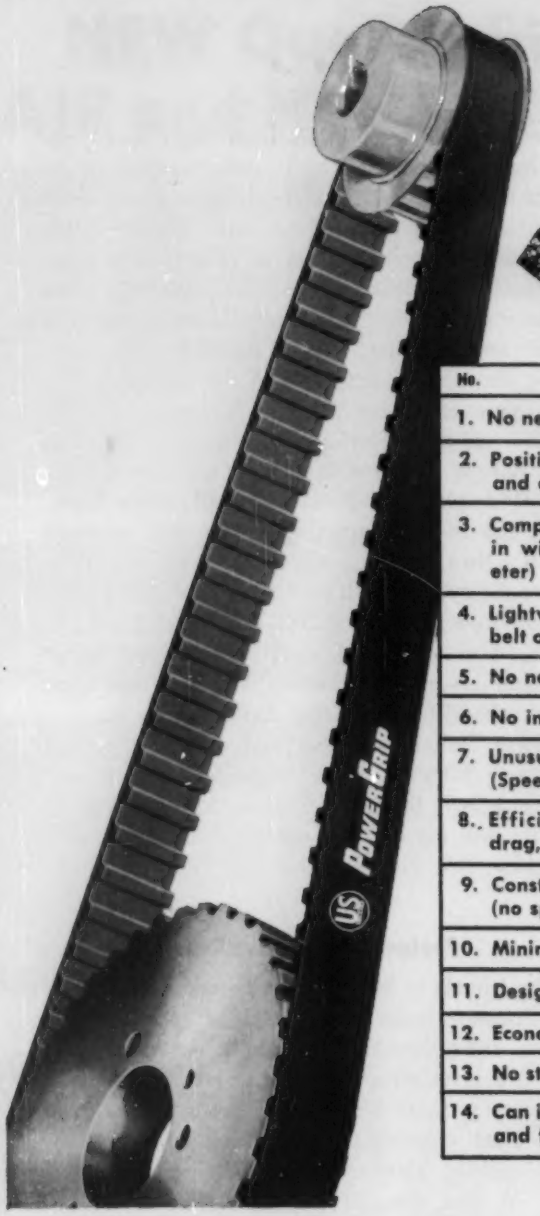
A.O.Smith
CORPORATION
integral hp
motors



Single phase,
Polyphase...
Drip-proof

IN THE FOLLOWING NEMA FRAME SIZES:
182, 184, 213, 215, 254, 256,
203, 204, 224, 225 and 256U.

A. O. Smith integral
horsepower motors (1-10 hp) are
designed and built for long-life, minimum
maintenance and maximum
reliability.



"√" in your transmission belt needs

No. Advantages	PowerGrip "Timing" Belt	Chain	Gear	V-Belts	Flat Belts
1. No need for lubrication	√				
2. Positive elimination of slip and creep	√				
3. Completely compact (Both in width and pulley diameter)	√				
4. Lightweight (Heavy duty belt only 0.1 lb./ft./in.)	√				
5. No noise or vibration	√				
6. No initial tension	√				
7. Unusual speed range (Speeds up to 12,000 FPM)	√				
8. Efficient (Elim. heat, lube drag, high bearing loads)	√				
9. Constant angular velocity (no speed fluctuation)	√				
10. Minimum backlash	√				
11. Design flexibility	√				
12. Economical	√				
13. No stretch	√				
14. Can it be completely housed and forgotten?	√				

Note that the U. S. PowerGrip "Timing" Belt takes a "√" after every advantage

While every type of drive has certain advantages, *no* type of power transmission possesses *so many* advantages as the U.S. PowerGrip "Timing" Belt drive. For example, *it is the only positive drive that never needs lubrication.*

THE LIST OF USES GROWS DAY BY DAY! Power production machinery in every field is made more efficient, volume of production increased, and maintenance costs lowered with this amazing belt. The list of OEM applications grows too numerous to mention. U.S. PowerGrip has streamlined hundreds of products... made them sell above competition. Some equipment would not be in existence at all, if it weren't for this great belt.

Immediate delivery of stock drives with ratios up to 12 to 1 is obtainable from any of United States Rubber Company's selected distributors or any of the 27 "U.S." District Sales Offices, or the address below.

Send for free illustrated manual, complete with standard drive tables.

"U. S." Research perfects it..."U. S." Production builds it... U. S. Industry depends on it.

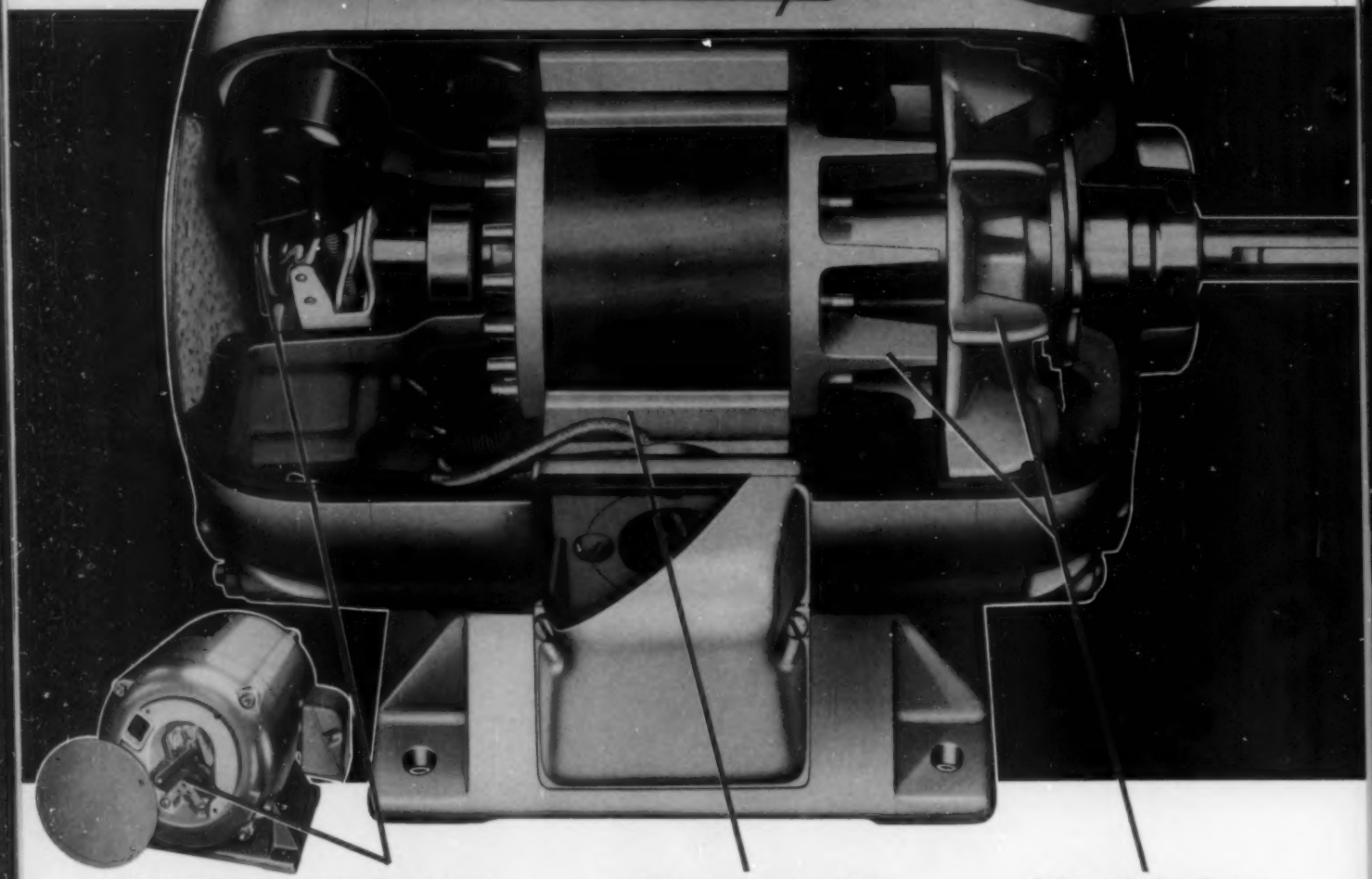
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Look inside for the reasons why

SINGLE-PHASE



New Separately-Sealed Starting Switch!

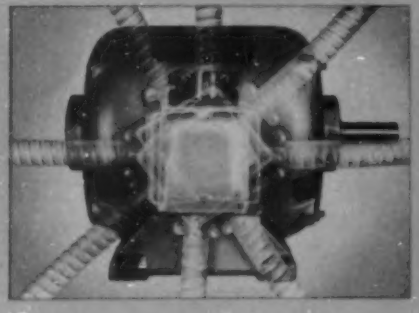
An exclusive A. O. Smith development, the totally-enclosed, fully-protected starting switch is located in the end frame. Starting switch is kept clean which means longer service. To service switch there's no need to remove motor from line. Just remove end cover . . . only seconds required to get to starting switch . . . only four screws to remove.

Moisture-Resistant Stator

Stator core assembly is built up of high-grade, silicon laminations welded together into a compact, uniform unit. Stator is dipped in special insulating varnish and baked, preventing moisture and corrosion from attacking the coils and laminations. Stator windings are made of heavy Formvar wire and covered with insulation of high dielectric and mechanical strength.

Efficient Cooling System

Large fan supplies ample amount of cool air over the coils. The controlled ventilating system helps keep bearings clean from dirt, dust and other foreign matter.

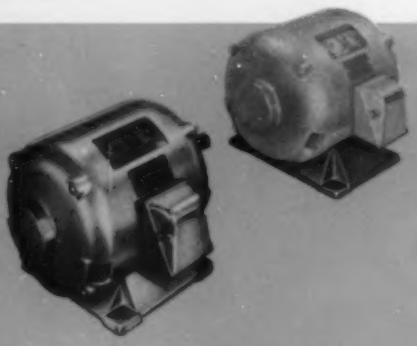


FULL-ROTATING CONDUIT BOX

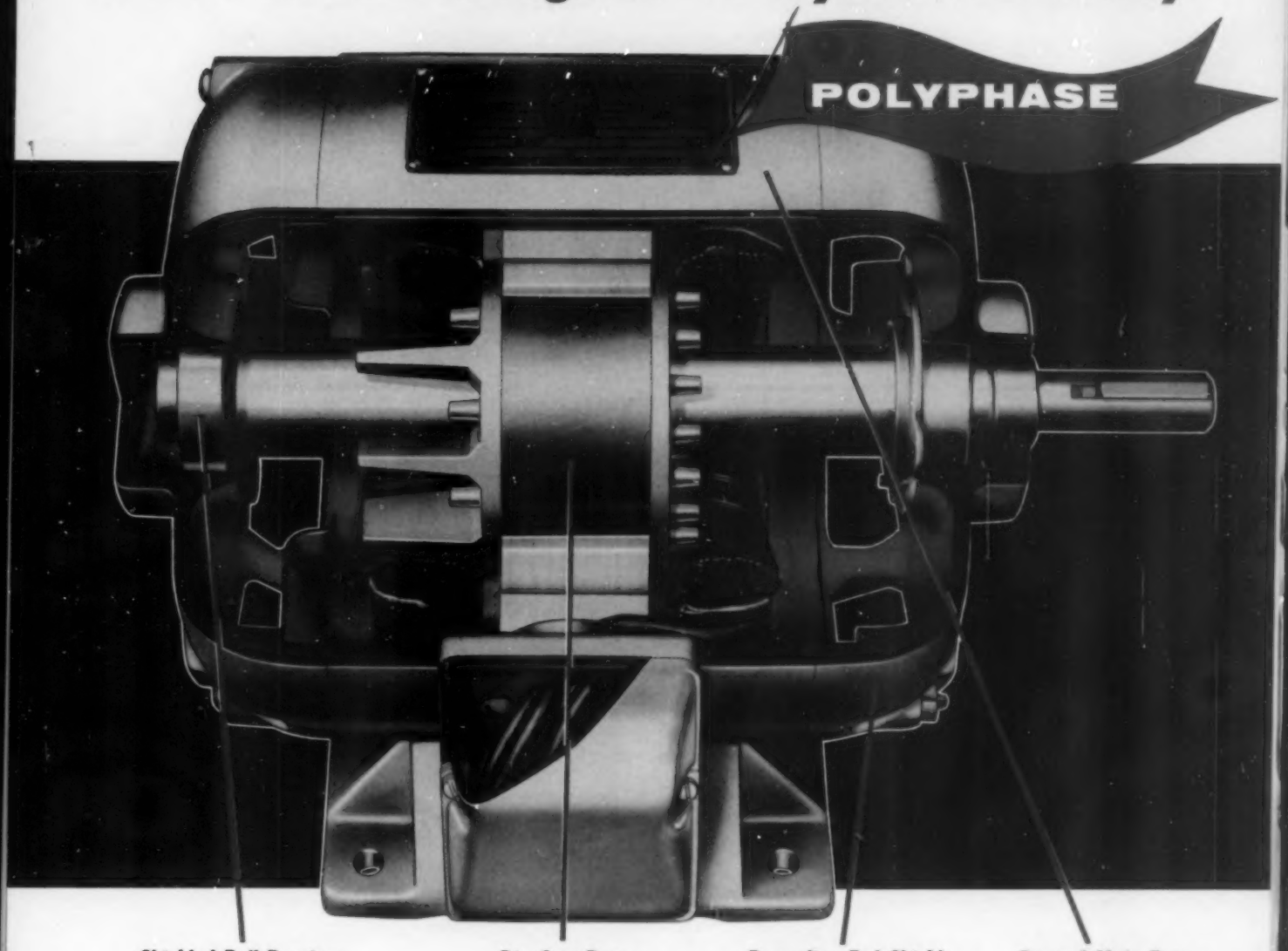
By simply removing cover and loosening three screws the roomy conduit box can be rotated to any position through 360° for more convenient installation. Box contains ample space for easy connection of leads.

OPTIONAL FRAME MOUNTINGS

There's no need to change product design to use new NEMA frame sizes — 182, 184, 213, 215. A. O. Smith integral horsepower motors are offered with optional frame mountings—drilled to old specifications or the new.



A. O. Smith integrals are your best buy



Shielded Ball Bearings

Ball bearings and enclosures are grease packed. Protective design prevents escape of lubricant, keeps out foreign matter. Shielded bearings are designed for even load distribution under all working conditions, assuring minimum maintenance.

Die-Cast Rotor

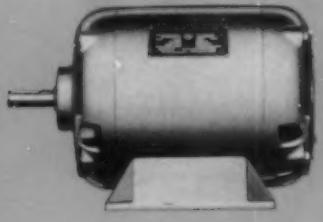
Rotor is aluminum die-cast and is made up of punched laminations of high-quality silicon steel. It's dynamically balanced. As a result, you get smooth, vibrationless operation, trouble-free performance.

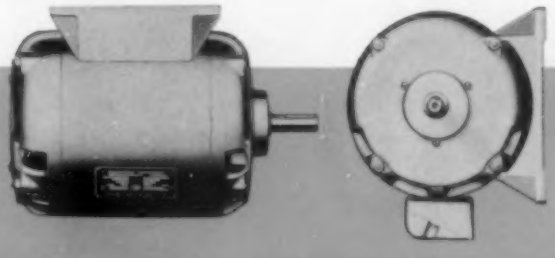
Permalign End Shields

Precision-built, end shields provide rigid support for bearings. As a result, you're assured of maximum bearing life and permanent rotor alignment.

Rugged Main Frame

One-piece main frame is constructed of rolled steel. This construction provides extra strength and rigidity under stress and physical abuse that would crack ordinary frames.





DRIP-PROOF AT ALL ANGLES

Integral hp motors, mounted in any position, are fully drip-proof. This feature is possible because the A. O. Smith motors use through ventilation so that the end frames can be rotated to keep the motor drip-proof in any position within the 360° cycle.

A. O. Smith integral hp motors are built in polyphase, ½ thru 10 hp, and single-phase, ¾ thru 5 hp, in various standard speeds and frequencies. Available with NEMA C and D flanges plus special flanges as required.

A. O. Smith's electric motors are precision-built at this modern plant in Tipp City, near Dayton, Ohio. Manufacturing facilities cover nearly 200,000 sq. ft. of floor space, with more than 600 skilled motor-builders employed. Write for Bulletin EM154 which takes you on a tour of our plant to acquaint you with the modern, cost-reducing operations that give you better motors for top performance.

the significance of application engineering

A. O. Smith integral hp motors (1-10 hp) are widely recognized for dependability of service and low-cost maintenance. • This is true because they are application-engineered to meet customer requirements. Specific application engineering is accomplished by maximum use of various standard features, blended perfectly with special parts to meet your exact specifications. • A. O. Smith designs integrals to fit your job — *precisely*. Long life and minimum service problems are assured. • When it comes to integral hp motors, it's good business to contact A. O. Smith.

A nationwide network of factory service stations gives you prompt 24-hour action on all motor parts and service calls. Write for list of the service station that's nearest you.

The A. O. Smith name stands for progress and quality

When you deal with A. O. Smith, you're dealing with one of America's great corporations. This name appears on the world's most popular water heater — Permaglas, glass-lined and rust-proof — proved in more than 2,500,000 homes. This name appears on fine welding machines and electrodes . . . on pressure vessels and refinery heat exchangers . . . on pressed steel automobile frames. On all these products, and many more, the A. O. Smith name stands for great PERFORMANCE backed by creative research.

Bulletin No. EM156

Through research A.O. Smith Research ... *a better way*

A.O.Smith

CORPORATION

ELECTRIC MOTOR DIVISION
227 East Helena Street
Dayton, Ohio

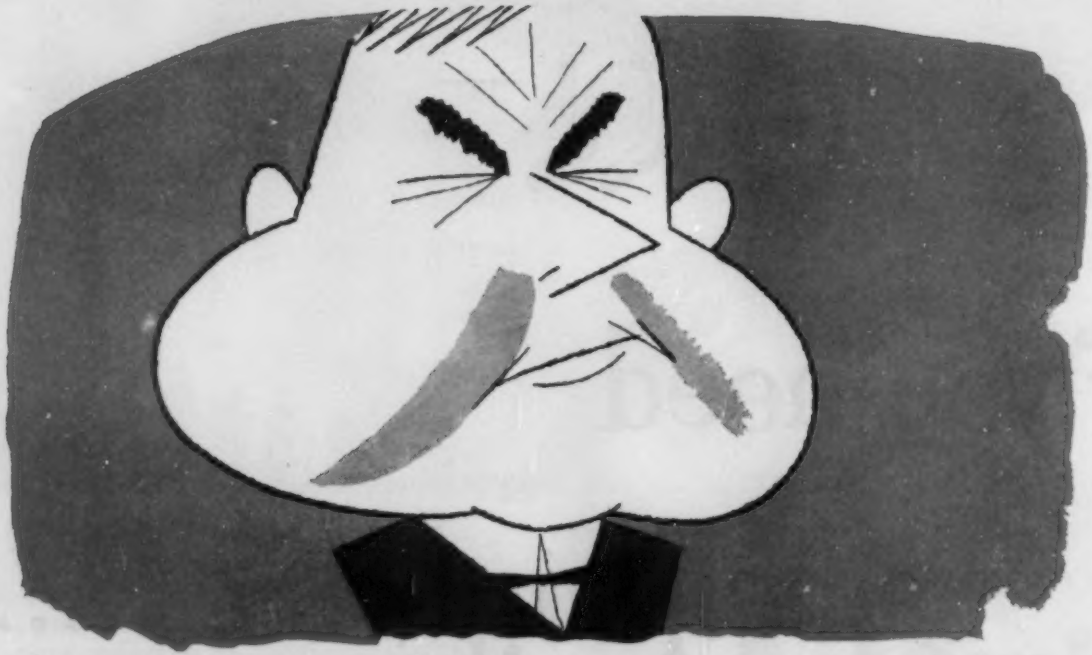
International Division: Milwaukee 1, Wisconsin

If you need a helping hand.....

If you need more elbow room...

If you need more space and don't know where to get it, your Kaiser Aluminum Distributor can probably help. By drawing on his large inventory, you can use much of your present storage space for production. Or, if you're tight on cash, just eliminate your storage space and thus reduce your overhead.

think of your *Kaiser*



If you've bitten off more than you can chew...

If you find yourself with more work than you can handle, your Kaiser Aluminum Distributor can help. He's geared to meet your emergency needs, to go to work for you the minute you call. He stocks a wide variety of aluminum and can provide you with almost any size, shape or alloy—cut to your needs.

If you're stuck with high costs...

You can reduce your raw material outlay and cut your handling and insurance costs by drawing on the large stocks of your Kaiser Aluminum Distributor. You can use *his* inventory as your own . . . because he can give you machine-side delivery as you need it.

Aluminum Distributor

All these services mean more profits for you because they help lower your costs!

Call your Kaiser Aluminum Distributor today! You'll find his name on the next page!

Kaiser Aluminum Distributors

ATLANTA, GEORGIA
Warehouse Division, Atlantic Steel Co.
Phone: Emerson 3451

BALTIMORE, MARYLAND
Hill-Chase Steel Co. of Maryland
Phone: Peabody 2-7300

BEAUMONT, TEXAS
Standard Brass & Mfg. Co. Phone: 4-2641

BIRMINGHAM, ALABAMA
Hanna Steel Corporation Phone: 9-2127

CHICAGO METROPOLITAN AREA
Fullerton Steel & Wire Co. Phone: Merrimac 7-2700
Korhumel Steel & Aluminum Co., Evanston, Illinois
Phone: Ambassador 2-6700
Miratile Mfg. Company Phone: Hudson 8-2200
(Serves House Trailer Industry only)

CINCINNATI, OHIO
Morrison-Drabner Steel Co. Phone: Wabash 1-4480

CLEVELAND, OHIO
Copper & Brass Sales, Inc. Phone: Endicott 1-6757
Nottingham Steel Company Phone: Atlantic 1-5100

DALLAS, TEXAS
Delta Metals, Inc. Phone: Logan 7443
Earle M. Jorgensen Co. Phone: Riverside 1761

DAVENPORT, IOWA
Nichols Wire & Aluminum Co. Phone: 3-1895

DETROIT, MICHIGAN
Copper & Brass Sales, Inc. Phone: Lorain 7-3380
Steel & Aluminum Products Corp.
Phone: Vermont 6-9285

GRAND RAPIDS, MICHIGAN
Copper & Brass Sales, Inc. Phone: Empire 1-6681

HONOLULU, T. H.
Permanente Cement Co. Phone: 5-2541

HOUSTON, TEXAS
Earle M. Jorgensen Co. Phone: Orchard 1621
Standard Brass & Mfg. Co. Phone: Capitol 6531

INDIANAPOLIS, INDIANA
Hubbell Metals Inc. Phone: Hickory 9261
F. H. Langsenkamp Company Phone: Imperial 4321

KANSAS CITY, MISSOURI
Hubbell Metals Inc. Phone: Baltimore 7760

LOS ANGELES, CALIFORNIA
Eureka Metals Supply Co. Phone: Mutual 7286
Earle M. Jorgensen Co. Phone: Lorain 7-1122
Reliance Steel Company Phone: Adams 3-3193

MIAMI, FLORIDA
Fullerton Metals Co. Phone: 84-3165—84-2490

MILWAUKEE, WISCONSIN
Korhumel Steel & Aluminum Corp. of Wis.
Phone: Evergreen 4-6000

MINNEAPOLIS, MINNESOTA
Korhumel Steel & Aluminum Co.
Phone: Geneva 2661

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Orleans Steel Products Co., Inc.
Phone: Raymond 2116
Standard Brass & Mfg. Co. Phone: AUdubon 1381

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A. R. Purdy Company, Inc., Lyndhurst, N. J.
Lyndhurst: Phone Webster 9-8100
New York: Phone Chelsea 3-4455
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OAKLAND, CALIFORNIA
American Brass & Copper Co.
Phone: Higate 4-2366
Gilmore Steel & Supply Co.
Phone: Glencourt 1-1680
Earle M. Jorgensen Co. Phone: Higate 4-2030

PHILADELPHIA, PENNSYLVANIA
Hill-Chase & Company, Inc.
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PITTSBURGH, PENNSYLVANIA
William M. Orr Co., Inc. Phone: Churchill 2-3000

PORT ARTHUR, TEXAS
Standard Brass & Mfg. Co. Phone: 5-9377

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Eagle Metals Inc. of Oregon Phone: Tuxedo 5201

SAN FRANCISCO, CALIFORNIA
Gilmore Steel & Supply Co.
Phone: Klondike 2-0511

SEATTLE, WASHINGTON
Eagle Metals Company Phone: Lander 9974

SHREVEPORT, LOUISIANA
Standard Brass & Mfg. Co. Phone: 2-9483

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Eagle Metals Company Phone: Keystone 0587

ST. LOUIS, MISSOURI
Hubbell Metals Inc. Phone: Franklin 1-0212

SYRACUSE, NEW YORK
A. R. Purdy Co., Inc. Phone: Syracuse 72-6677

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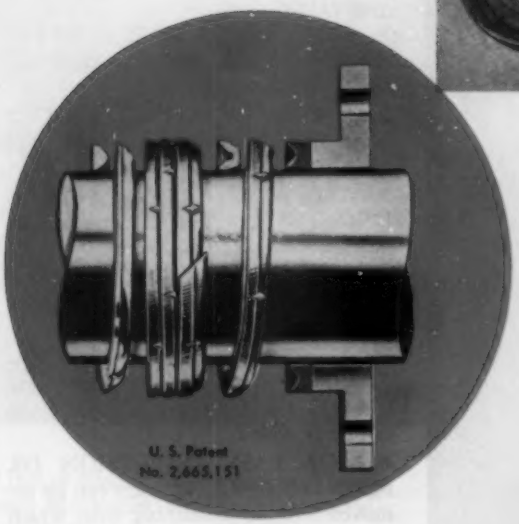
Really leakproof!

Linear VEE-DAM® rings



HERE'S A UNIQUE, revolutionary split V-Ring design that positively stops both labyrinth flow and lateral leakage!

LINEAR VEE-DAM RINGS don't require precise fitting. Even when gaps occur at the ring joints, through careless installation or variations in bore size, fluid can't leak past the rings. Here's why: *Sturdy Rubber Dams* (A) in the grooved hinge area hermetically seal off center groove sections. When rings are stacked together, these dams eliminate all labyrinth flow. *External abutments* (B) on the ring shoulders prevent lateral leakage and provide stabilizing support.

Let us show you how **LINEAR VEE-DAM RINGS,** engineered to your application in a choice of fabric reinforced synthetic rubbers, save you installation and maintenance time, and assure you absolutely leakproof packing over a wide temperature range.

"PERFECTLY ENGINEERED PACKINGS"

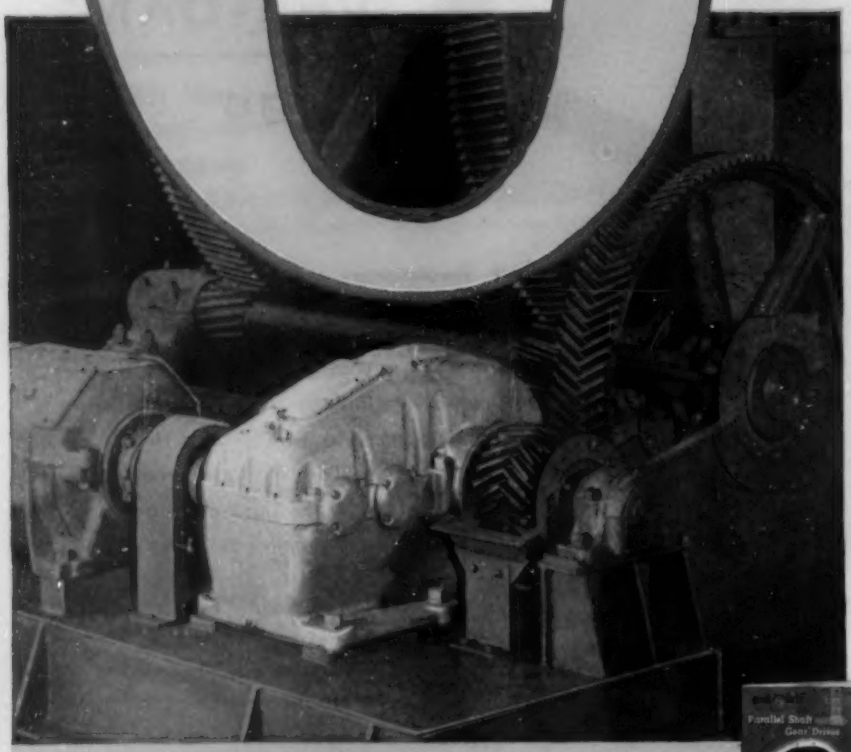
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

6 reasons why

Link-Belt Parallel Shaft Gear Drives

ASSURE CONTINUOUS PRODUCTION



Ten-ton coils of hot strip steel are transferred by this up-ender in a modern mill. Link-Belt parallel shaft gear drive fitted with outboard bearing on output shaft withstands the exceptionally tough duty.

LINK-BELT'S compact, self-contained parallel shaft gear drives are designed to avoid common problems encountered in transmitting heavy shock loads. Here's how:

1. FOR DEPENDABLE OPERATION gears are precision-machined, shafts rigidly supported.
2. TO WITHSTAND HEAVY SHOCK and overhung loads, ball and roller bearings are used throughout.
3. TO PREVENT ENTRANCE OF DIRT and moisture, effective grease-lubricated seals are used on all shafts.
4. FOR SUPPLYING OIL to each rotating part at all speeds, automatic splash lubrication is used.
5. TO PREVENT REVERSE ROTATION on conveyors, elevators and similar equipment, a built-in backstop can be provided.
6. FOR EASY INSPECTION OR MAINTENANCE, all parts can be removed without disturbing base, which can be grouted in concrete.

Book 2619 gives complete details. Get a copy from your Link-Belt office or authorized stock carrying distributor. Or write direct.

Get JOB-MATED drive combinations from the complete Link-Belt line

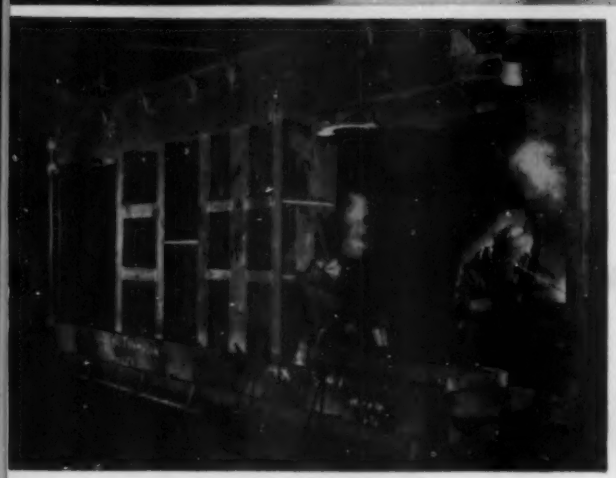
In addition to parallel shaft gear drives, Link-Belt builds in-line helical and worm gear drives, Gearmotors, Motogears, variable speed drives, fluid drives, chains, sprockets, couplings, bearings, etc. All are pre-engineered for easy installation and maximum efficiency.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,874

50-ton crane becomes 85-ton crane
with no increase in size



United States Steel's Edgar Thomson Works in Braddock, Pennsylvania, needed new and heftier crane equipment to handle larger ladles. One requirement was four new crane trolleys which were to operate on the same bridges, if possible, and in exactly the same clearances as before.

The trolleys had to be stronger but no larger than before; so ordinary steel wouldn't do. Needed, was a steel of *exceptional strength* which could be *welded easily*. Lots of alloy steels could have met the strength requirements; but USS "T-1" Steel was the *only* steel that could supply not only the required strength, but good weldability as well.

"T-1" Steel plate—in ¾" and 1" thicknesses—was used in box girders and lateral stiffener plates of the trolleys. This change increased the crane capacity from 50 to 85 tons with no increase in size.

The structure was welded with AWS E12015 electrodes. It was as easy as welding carbon steel. No stress relief was needed. And the welds developed the full yield strength of the steel: 90,000 psi. minimum.

Remember this story when you must weld very high strength parts—parts that must operate at temperatures as high as 900°F. or as low as 40°F. below zero, parts that must withstand tremendous impact abuse, abrasion or tensile stress. Then consider USS "T-1" Constructional Alloy Steel. For full particulars write: United States Steel, Room 4960, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

UNITED STATES STEEL

PROVIDE HORIZONTAL FLOAT

HY POTENUSE, the sage of the slide rule, SAYS:

Ever have herringbone gears bind on you because the shaft couldn't float freely to permit the gears to mate properly? It can happen when you use laterally locked bearings—*but it can't happen here!*

The designer of this pump assembly has made doubly durn sure *he* won't get into trouble—by specifying HYATT A-6200-T Cylindrical Roller Bearings. *First*, he knows they'll provide plenty of lateral float so the herringbone gears can mesh freely (and to take care of possible shaft expansion in case hot liquids are pumped). *Second*, a single bearing with two rows of rollers gives him maximum load capacity in minimum space—without any possibility of overload on one bearing or the other that might creep in if he used two separate bearings.

If you haven't a HYATT General Catalog No. 150 handy, better send for yours pronto, brother—it'll save you a heap of time and headaches! *Remember, you can't go awry when you specify—*

your COMPLETE LINE of cylindrical roller bearings

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Massive boom built of USS TRI-TEN Steel

helps to keep this giant shovel working around-the-clock all year 'round

This machine is moving an average of well over 1,200,000 cu. yds. of overburden a month at the Wright Mine of the Boonville Collieries Corporation, subsidiary of Ayrshire Collieries Corp. of Indianapolis, Ind.

To pay off on the more than a million-and-a-half dollars invested in this mammoth 45-cu. yd. power shovel it must operate *continuously*—24 hours a day, day after day, every month in the year.

That's why the engineers of the Marion Power Shovel Co., Marion, O., selected USS TRI-TEN Steel for all plates, angles and tees in the massive 120 ft. boom. For this tough, versatile steel not only has great strength—a 50% higher yield point than carbon steel—but in addition possesses an important advantage well proved in other similar construction . . . it has the unusual ability to withstand shock and stress at sub-zero temperatures. Here in short is a true *all-weather* steel.

In other words, when the thermometer drops to the point where a less efficient steel might tend to crack and fail in service, USS TRI-TEN construction can confidently be depended upon to keep the equipment profitably on the job.

Not only in booms like this, but in drag line buckets, heavy-duty truck frames, bull-dozers and power shovels that must be kept working hour after hour in any kind of climate, USS TRI-TEN Steel and its companion, USS TRI-TEN "E" Steel, have proved their superiority by minimizing breakdown hazards. In hundreds of heavy-duty applications, where dependability is of prime importance, the use of these high strength steels has resulted in the kind of uninterrupted operation that spells bigger output at lower cost.

NOW AVAILABLE . . . Our new "Design Manual for High Strength Steels" is ready for distribution. This 174-page book is free. It contains comprehensive and practical information that you will find extremely useful in designing your equipment for greater economy and efficiency by the sound use of high strength steels. For your copy, write on your company letterhead giving your title or department, to United States Steel Corporation, Room 4939, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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USS HIGH STRENGTH STEELS

5-1834

USS TRI-TEN • USS COR-TEN • USS MAN-TEN

UNITED STATES STEEL

Taking the noise out of sound

3M COMPANY

With movable wall panels, like those pictured above, you can build a room anywhere—in the factory, in the office, in the laboratory. But the new room would be impractical unless it were protected from outside vibration and noise. That's where 3M comes in.

EC-1000 is a vibration and sound damping coating that withstands high temperatures directly after application. Immediately after EC-1000 is sprayed on the back side of the metal panels, they are primed and run through the baking ovens! There's no lost motion . . . no production line slowdown. And once installed, walls treated with EC-1000 make a room that is quieter, easier to work in, relatively unaffected by external noise and vibration.

See what adhesives can do for you...

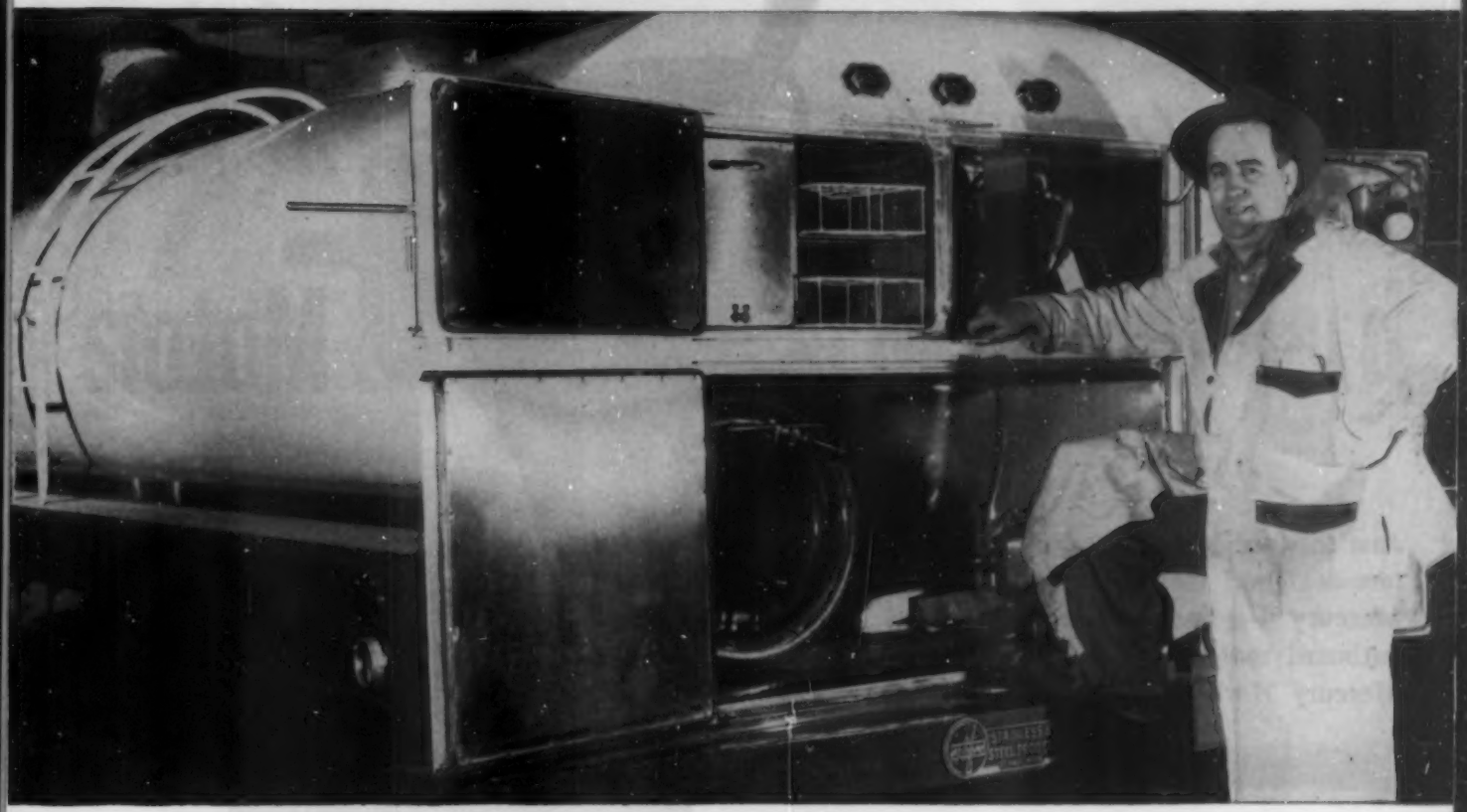
Perhaps you have a production problem 3M can help you solve. A 3M field engineer will be glad to consult with you on your specific requirements. Or, for a free booklet on cost-cutting 3M adhesives, write 3M, Dpt.410,417 Piquette Ave., Detroit 2, Mich.

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

The complete pick-up tank is supplied with sample compartment, pump and hose. Stainless Steel is used for both interior and exterior surfaces. Stainless & Steel Products Company, St. Paul, Minn., is the manufacturer.



This tank truck had to be made from Stainless Steel

Tank shells are rolled on a 10′ roll. Notice adhesive cloth tape used to protect inside surface of tank until job is complete.

The dairy and dairy equipment industries have been awfully busy these past few years, working out ways to reduce costs and maintain the flavor and quality of milk.

One major step has been *bulk milk* pickup. Instead of storing his milk in cans, today's modern farmer uses a Stainless Steel storage tank. Then, every-other-day, the dairy sends a tank truck to pick up the milk. The tank on the truck has to be made from Stainless Steel, because no other metal has such a unique combination of strength, corrosion resistance and cleanability.

The manufacturer of this tank truck uses Types 302 and 304 Stainless Steel—14-gauge shells for tanks 2000 gallons and under, 12-gauge for tanks 2000 to 5000 gallons. Both gauges are sheared, rolled and punched on equipment with a nominal capacity of 3/8″ carbon steel. Holes are cut with a carbon-arc torch, and all fittings are attached with electric arc welding.

If you have been wondering whether you can handle Stainless Steel successfully in your own shop with your present equipment, just remember that fabrication of Stainless Steel isn't difficult — it's just different.

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AMERICAN STEEL & WIRE DIVISION, CLEVELAND
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USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

USS

UNITED STATES STEEL

Just turn the key..

An R&M Motor

Just turn the key, and a Robbins & Myers custom-designed motor starts the powerful new Mercury 4-cylinder-in-line Mark 55E 40 HP outboard motor, and also the popular 18 HP Mercury Mark 25E model.

This outstanding electrical starter and generator system is the result of extensive research and design work by engineers of the Kiekhaefer Corporation, Fond du Lac, Wisconsin, makers of Mercury outboard motors. Rigid requirements were established on all parts to assure unfailing performance and long service under the conditions in which outboard motors must operate.

One of the most important single factors is the starting motor. It must operate on the 12-volt system, be compact, provide high torque. It must withstand the heavy starting load, rough handling, vibration, exposure to marine conditions. Kiekhaefer engineers handed the problem to Robbins & Myers motor design specialists.

These R & M engineers custom-designed the motor for the job. It develops 8/10 HP at 6000 RPM. It's compact, with an overall length of 6 inches and outside diameter of less than 3½ inches. Commutator, windings, and connections are specially designed for 12-volt service. The motor shaft is specially splined and hardened to resist sudden starting loads. The whole motor is marine-treated with special moisture-proofing to protect it against fresh and salt water, and tropicalized with fungicidal lacquer.

Kiekhaefer engineers, after extensive tests, report that the R & M motor amply meets all the requirements. It has now been used on the Mark 55E and Mark 25E for millions of enjoyable hours. Users are enthusiastic about the smooth, unfailing performance of the "Turn-the-Key" starting system.

Above, cutaway view of the Mercury Mark 25E outboard motor showing location of the R & M starter, and, right, R & M matched motor parts custom-designed especially for this application. Parts are marine-treated and tropicalized to resist salt water and fungus.

starts this new Mercury outboard

How R & M Engineers coordinate motors with your machine design

The Mercury electric motor starter is just one of thousands of applications that require a custom-designed motor. Robbins & Myers engineers specialize in integrating motors with your design problems in building a machine.

We custom-design matched motor parts for portable tools, industrial equipment, appliances, office machines, many other applications. R & M engineers have developed a special electric "slide rule" that cuts motor designing calculation time from months to days. The resultant cost and time savings are passed on to you.

It may be that an R & M standard motor will completely meet your requirements. If so, we can select from our wide choice of types and sizes of complete motors or matched motor parts.

But don't be satisfied with an "off-the-shelf" compromise. Bring your problems to R & M—we'll work with you—in complete confidence—and you can be sure of getting the motors or motor parts that best meet your requirements. Call the nearest Robbins & Myers office—or mail the coupon below for complete information about R & M service.

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R & M Motors and Motor Parts power many types of equipment

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TORRINGTON Spherical Roller Bearings

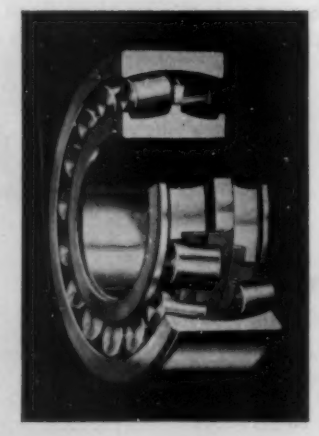
are manufactured with accurate geometrical conformity between races and rollers for ultimate capacity and performance.

Because conformity factors are uniformly high, rollers can operate with a minimum of friction and carry greater loads for a longer time.

There are other good reasons why TORRINGTON SPHERICAL ROLLER BEARINGS can guarantee superior performance. Races and rollers are precision ground to a high surface finish from the finest quality electric furnace steel available.

An integral center flange on the inner raceway gives positive radial and thrust stability against continuous high-speed, high-load conditions. Fully machined, cast-bronze, land-riding cages—one for each path of rollers—allow thorough lubrication, reduce wear and lengthen bearing life.

Specify dependable, rugged TORRINGTON SPHERICAL ROLLER BEARINGS in your equipment. They're available with either straight or tapered bore for shaft or adapter mounting.



THE TORRINGTON COMPANY
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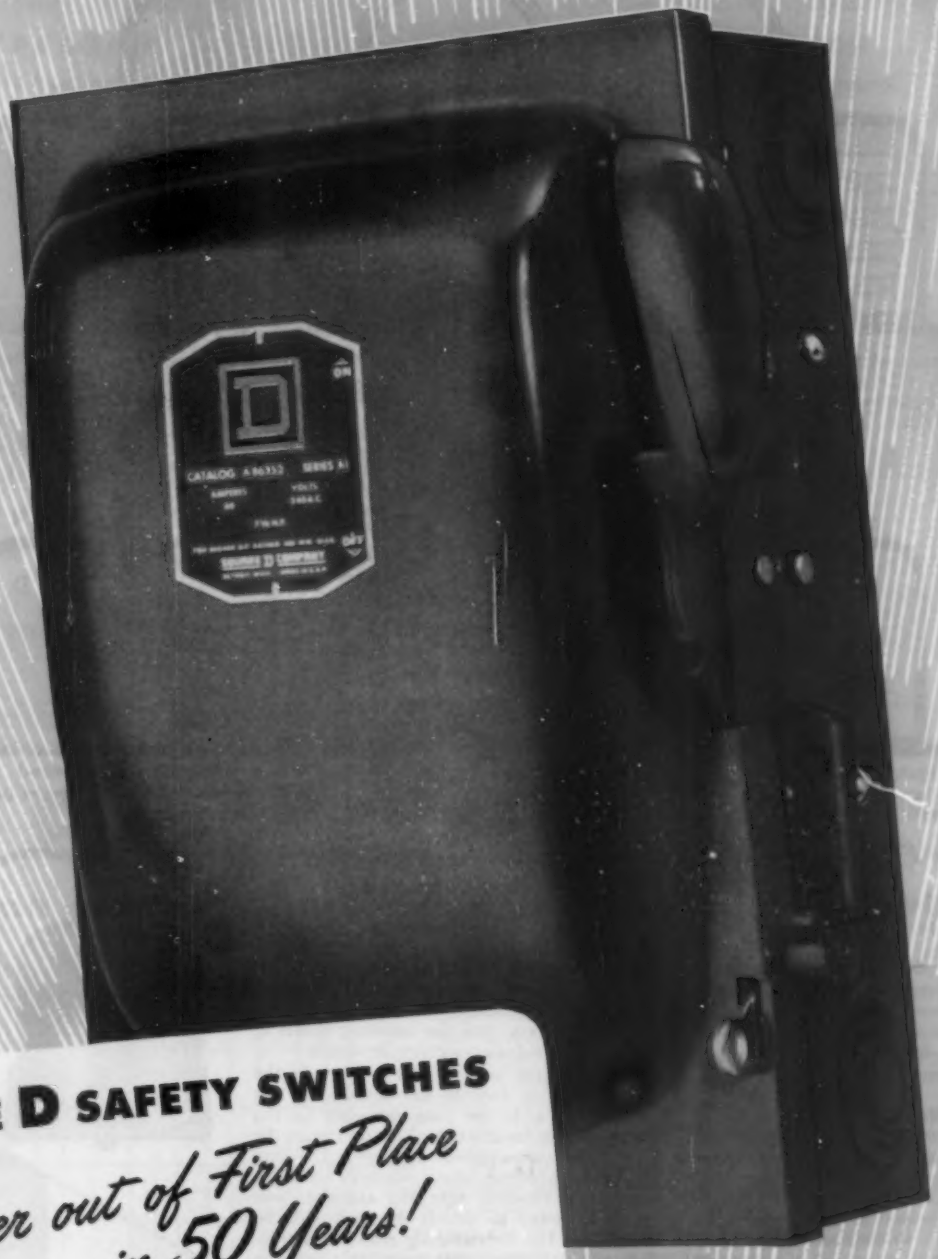
TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers



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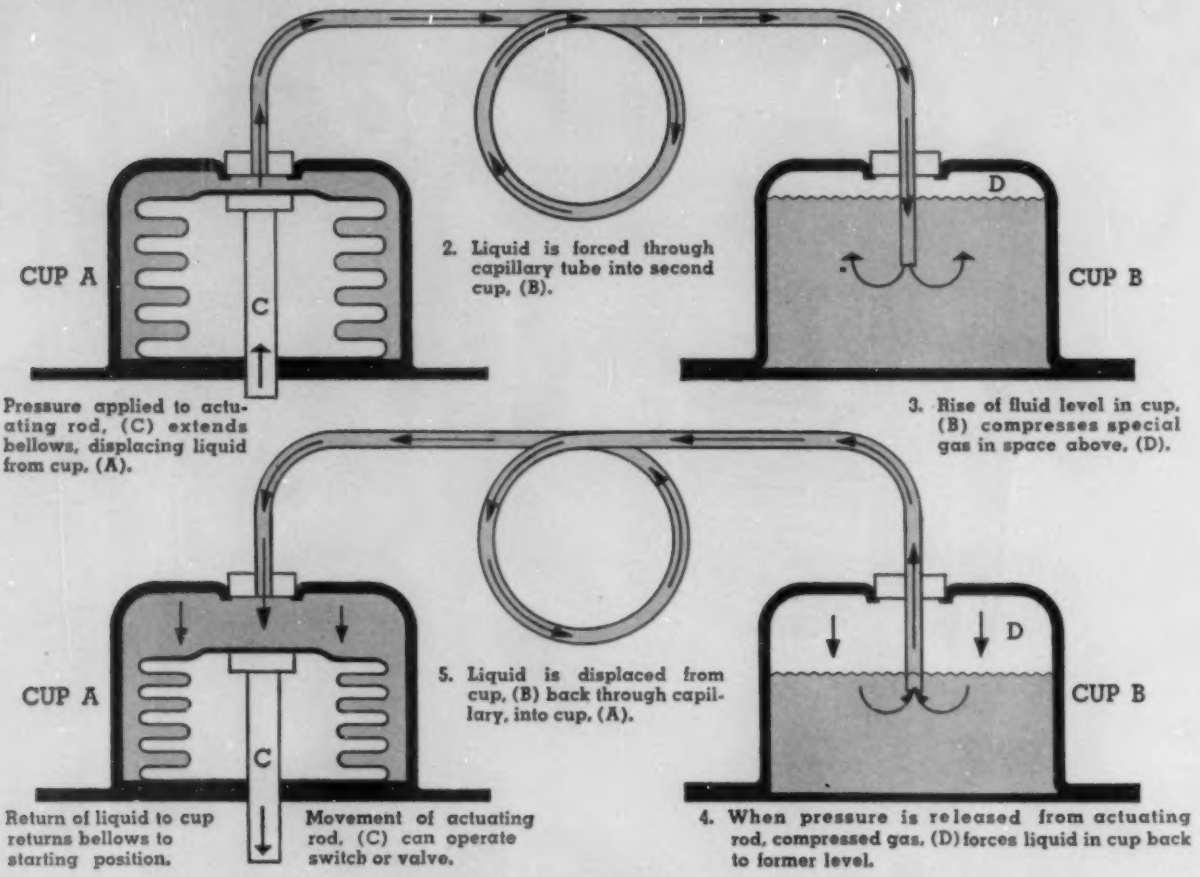
SQUARE D COMPANY

How To Provide For Time-Delay Action With A Low Cost Bellows Device


CUP A
C
D
CUP B
2. Liquid is forced through capillary tube into second cup, (B).
1. Pressure applied to actuating rod, (C) extends bellows, displacing liquid from cup, (A).
3. Rise of fluid level in cup, (B) compresses special gas in space above, (D).
5. Liquid is displaced from cup, (B) back through capillary, into cup, (A).
6. Return of liquid to cup returns bellows to starting position.
Movement of actuating rod, (C) can operate switch or valve.
4. When pressure is released from actuating rod, compressed gas, (D) forces liquid in cup back to former level.

Simple Cup-and-Capillary unit operates hydraulically . . . provides delay times up to two minutes!

Time delay action can be accomplished with numerous devices. Electronic delay lines will provide delay times measured in microseconds. Electrical means such as relay circuits or motor powered timers, thermal means such as resistance wound bi-metallic strips and mechanical devices such as clock escapement mechanisms offer a wide selection of delay times.

Hydraulic devices, however, utilizing the movement of a flexible metallic bellows provide distinct advantages in many applications. Unlike either the electronic or electrical devices, bellows devices require no outside power. Unlike mechanical arrangements there are no springs, no moving parts, no mechanical linkage to break or get out of adjustment.

As indicated in the main illustration, the Clifford time delay unit consists of a standard bellows cup assembly connected by a capillary tube with another cup which forms an air tight chamber. Except for the inside of the bellows, the cup assembly (A) is completely filled with a liquid selected for the application. Cup (B) contains a measured amount of the liquid and the space above contains a special gas which is insoluble in the liquid. The capillary opening is so positioned that it terminates under the liquid and the gas is permanently trapped in the cup. An actuating rod is attached to the bellows in cup A.

Pressure applied to the rod extends the bellows, displacing the liquid from cup A, through the capillary to cup B. The rise in level in cup B compresses the gas temporarily and when pressure on the actuating rod is released, the compressed gas drives the liquid out of cup B back through the capillary and into cup A. With the return of the liquid, the bellows contracts and the resulting thrust of the rod can actuate switches or valves.

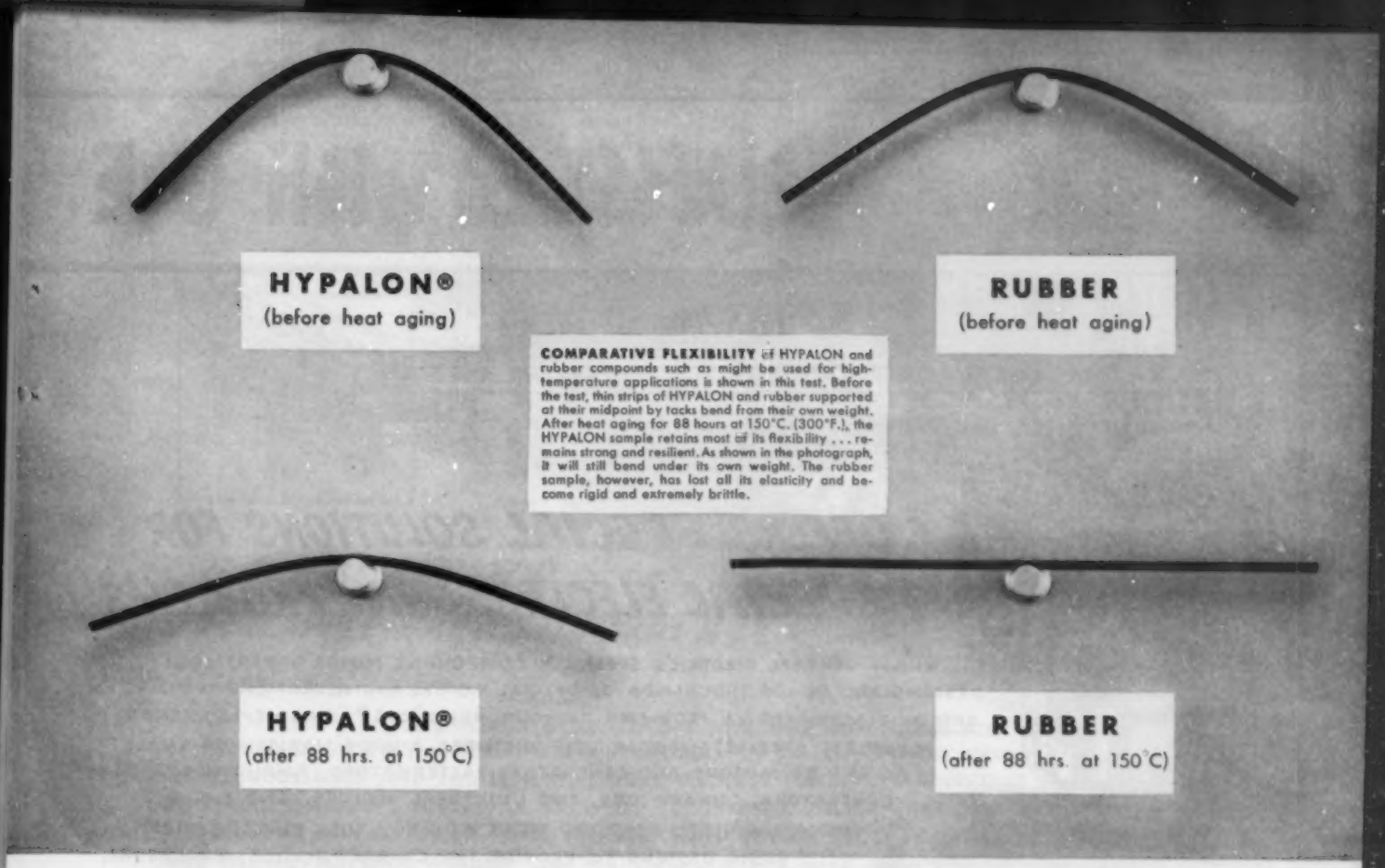
Delay interval is determined either by the time needed to displace the liquid from cup A to cup B or by the time necessary for the liquid to flow back into cup A and return the bellows to its original position. A filling liquid is selected whose viscosity remains essentially constant over the ambient temperature range to which the unit will be subjected. The hermetically sealed construction of the Clifford unit completely protects it from contaminants which tend to affect the time constant in units not so protected.

Standard units available. The Clifford Manufacturing Company can furnish standard units in production quantities having delay times of any selected period from one-quarter second to two minutes. Correct delay interval for the application can be obtained by selecting a suitable length and bore of capillary.

For appropriate units for your application, please send complete details covering: time constant required, force, ambient temperatures encountered and whether delay time is to be on forward or reverse stroke. **Clifford Manufacturing Company, 152 Grove St., Waltham 54, Mass.** *Division of Standard Thomson Corporation.* 7-5-67

Unit consists of two cup assemblies with appropriate length of capillary. It offers compact, rugged, hermetically sealed, low-cost design convenient for mounting. Time delay can be arranged for any interval from one-quarter second to two minutes and delay action can be on either the forward or return stroke.

HYDRON
METAL BELLOWS
CLIFFORD
MANUFACTURING CO.
WALTHAM, MASS.
DIVISION OF STANDARD-THOMSON CORP.
HEAT EXCHANGERS



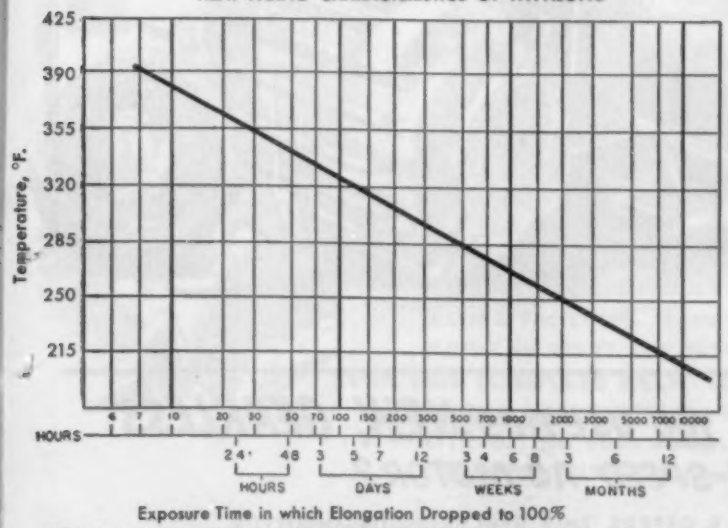
COMPARATIVE FLEXIBILITY of HYPALON and rubber compounds such as might be used for high-temperature applications is shown in this test. Before the test, thin strips of HYPALON and rubber supported at their midpoint by tacks bend from their own weight. After heat aging for 88 hours at 150°C. (300°F.), the HYPALON sample retains most of its flexibility . . . remains strong and resilient. As shown in the photograph, it will still bend under its own weight. The rubber sample, however, has lost all its elasticity and become rigid and extremely brittle.

NEW CHEMICAL RUBBER

DU PONT HYPALON®

maintains elastomeric properties at high temperatures

HEAT AGING CHARACTERISTICS OF HYPALON®



Exposure Time in which Elongation Dropped to 100%

NOTE: Graph shows continuous exposure time. Intermittent service, of course, greatly extends service life.

When resilient parts in your design must withstand high temperatures, be sure to evaluate products made of HYPALON, Du Pont's new chemical rubber. HYPALON has exceptional heat resistance . . . can operate in temperatures from 250° to 350°F. This means extra durability for the resilient components in your product . . . dependability under extreme service conditions. In addition to heat resistance, HYPALON also has many other advantages. For example:

HYPALON is completely resistant to ozone. Sustained exposure to ozone concentrations as high as 150 p.p.m. has no effect on HYPALON.

HYPALON has excellent chemical resistance. It resists oxidizing chemicals as well as many others.

HYPALON has superior color stability. Bright colors stay bright despite exposure to sunlight and weather.

HYPALON resists oil, grease, abrasion, flame and flex cracking. Almost all manufacturers who make rubber products can produce products of HYPALON. Uses include hose, coatings for fabric, rubber, wood and metal; gaskets, tank linings; molded and extruded parts. Be sure you get full details about HYPALON.

FREE BOOKLET. Here's your introduction to HYPALON—its properties and uses. Learn how you can use products made of this new chemical rubber to improve your design. Just clip coupon below for your copy.

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Elastomers Division, PE-10
Wilmington 98, Delaware

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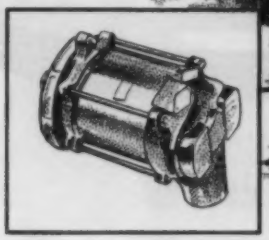
WHERE CAN YOU USE THIS NEW, GEARLESS LOW-SPEED AC MOTOR?

ONLY G.E. OFFERS THIS SYNCHRONOUS INDUCTOR MOTOR—OPERATING AT LOW SPEED ON 115 OR 230-VOLT AC POWER. LIMITLESS USES INCLUDE MOTOR-OPERATED VALVES, MACHINE TOOLS, REMOTE-CONTROL SYSTEMS. RAPID ACCELERATION, DECELERATION, REVERSING. SEALED-IN LUBRICATION FOR LONG LIFE.

TWO MODELS: 75 RPM, 75 OZ-IN.; 100 RPM, 2 OZ-IN.

specialty motors



SPECIAL G-E ALTERNATOR PUTS PINEAPPLE HARVESTING ON A 24-HOUR BASIS

... SPECIALLY DESIGNED G-E ALTERNATORS — RATED FOR CONTINUOUS DUTY IN AMBIENT TEMPERATURES UP TO 120°F — NOW PROVIDE POWER FOR FLOODLIGHTS AND SMALL HAND TOOLS ON HUGE PINEAPPLE HARVESTING MACHINES. THIS PERMITS HAWAII'S PINEAPPLE GROWERS TO OPERATE ROUND-THE-CLOCK TO GATHER THE FRUIT AT THE PEAK OF PERFECTION. **G-E APPLICATION "KNOW-HOW" PLUS QUALITY DESIGN AND MANUFACTURE** ASSURE LOW MAINTENANCE, MINIMIZE DOWNTIME.

AVAILABLE: COMPLETE ENGINEERING ASSISTANCE FOR YOU!

HERE'S THE SPECIAL ATTENTION YOUR PROBLEMS GET AT G.E.:
1. YOUR LOCAL G-E APPARATUS SALES ENGINEER LEARNS ALL ABOUT YOUR NEEDS FROM YOUR DESIGN PEOPLE.
2. HE CALLS IN A TEAM OF FACTORY ENGINEERS WITH YEARS OF MOTOR APPLICATION EXPERIENCE. 3. AT THEIR DISPOSAL ARE G.E.'S COMPLETE DEVELOPMENT AND TESTING FACILITIES. 4. IN SHORT ORDER, A SAMPLE G-E MOTOR IS READY FOR TESTING ON YOUR PRODUCT.

FOR THIS COMPLETE HELP, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE, TODAY. OR IF YOU PREFER, **WRITE** GIVING FULL DETAILS TO SECT. 704-58, GENERAL ELECTRIC CO., SCHENECTADY 5, N.Y.

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New precision in dimension—they can be held to the same tolerance as cavity moldings. And on I. D.—O. D. parts, the concentricity can be held much closer than by the ordinary extrusion process.

Lower durometer—With continuous molding. "U.S." cures stock as low as —35 durometer.

Shape retention—The cross section remains completely accurate because the cure (or vulcanization) is already complete when the product leaves the die. No supports needed, as in conventional extrusion.

Very thin wall thicknesses can be obtained—far thinner than conventional extrusion.

Improved density and finish—Continuous molding results in a product that is compacted to a mold finish and therefore far superior to a product of ordinary extrusion.

"U.S." Research perfects it...
"U.S." Production builds it...
U.S. Industry depends on it

Continuous molding is done only by United States Rubber Company. This great new process produces parts of natural rubber as well as synthetic rubber (GR-S, Neoprene or Nitrile) that are equal or superior to cavity-molded items. Get in touch with us at Rockefeller Center, New York 20, N. Y.

US RUBBER

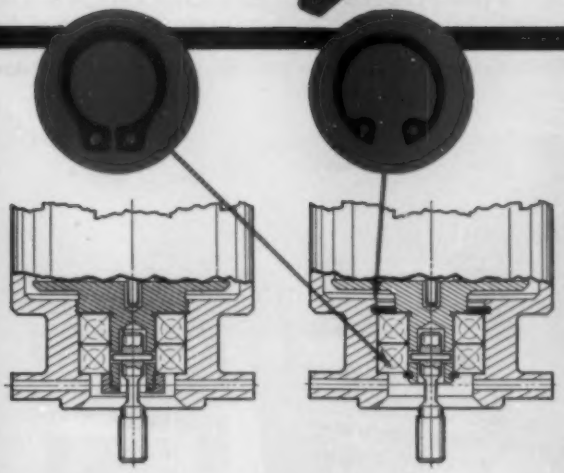
Mechanical Goods Division

United States Rubber

10 Waldes Truarc rings speed assembly— Eliminate parts and machining in precision control

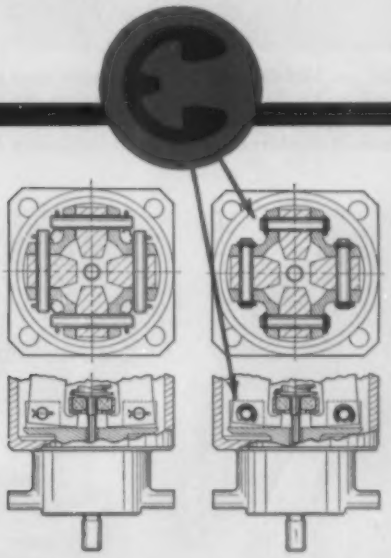
Kahn Rotary Speed Control

Kahn and Company, Inc., of Hartford, Conn., use a total of 10 Waldes Truarc Retaining Rings in this new mechanical-electric translator for automatic control of rotary speed. Truarc rings act as positioners and retainers to eliminate parts, simplify operations, save labor, and speed assembly.



Rotor Installation. In the old way, ball bearing was retained by a threaded shoulder and threaded bearing cup retainer.

New way, using two Truarc Rings (Series 5100 and 5000) eliminates 4 threading operations, bearing shoulder and threaded bearing cup. Assembly is quicker and easier, two ounces lighter.



Flyweight Assembly. Formerly, 2 holes had to be drilled in each of the 4 pivots, and 8 cotter pins were required.

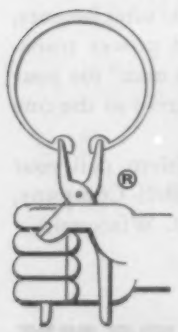
The new way, using 8 Truarc E-Rings (Series 5133), replaces holes with grooves, reduces pivot size, leaves no projecting parts. Rings snap into place, speed assembly time by three minutes per unit.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting ... Waldes Truarc Grooving Tool!



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TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

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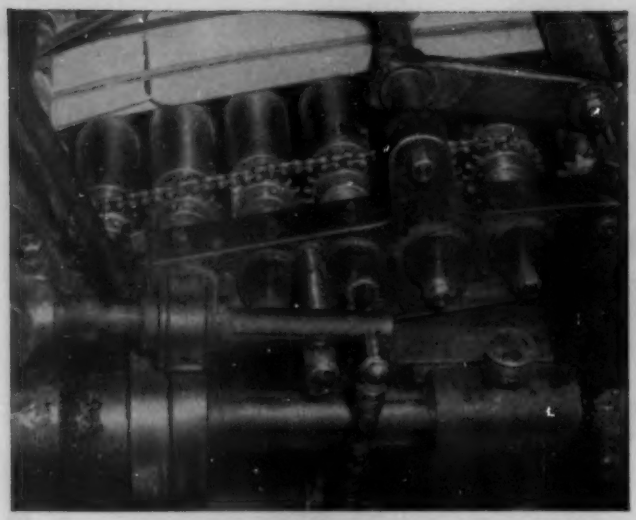
City.....*Zone*.....*State*.....

PN107

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



COSTS CUT . . . SPACE SAVED in a paper bag making machine. The CHAIN Belt Man recommended the replacement of 14 gears with a Rex® Roller Chain. Seven shafts eliminated . . . performance improved . . . rapid wear on gears and bearing eliminated.

DOWN TIME REDUCED in a bucket elevator. CHAIN Belt Man applied Chabelco® Steel Chains to overcome premature chain failure caused by shock loads, dirt, dust and heat. Built-in clearances of this chain provided efficient answer . . . cut down time.

HANDLING COSTS CUT in automotive plant. CHAIN Belt Man specified Rex TableTop® Chain to carry axle parts from hardening furnace to assembly line. Low-cost conveyor chain handles hot parts efficiently . . . rugged construction assures long life.

IMPROVED PERFORMANCE . . . LOWER COSTS of lift chains on fork truck due to CHAIN Belt Man's recommendation of Rex Leaf Chains. Standard roller chains used originally cost more . . . did not have strength or life of leaf chains for this service.

No Need to Do It Yourself . . .

Why not take advantage of the selection and application service offered by your Chain Belt Field Sales Engineer? With his broad background of experience in engineering chain drives and conveyors, he can help you save time, cut costs, improve product performance.

Your Chain Belt Man is more than a salesman . . . he's a chain application engineer. He knows your problem because he has solved similar problems. Backed by a complete line of chains, attachments, sprockets, roller bearings and related power transmission machinery, he can be an "extra man" for your engineering department . . . help you arrive at the one best answer for your problems.

If you have a chain application problem, call your Chain Belt Man. Or, write CHAIN Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wisconsin.

AT YOUR SERVICE
To help you with chain drive and conveying applications
YOUR CHAIN Belt Man

CHAIN BELT COMPANY

District Sales Offices in all principal cities

Point of Honor

From the collection of Lewis Winant, New Jersey Arms Collectors Club. Maker: Johann Kuchenreuter, Regensburg, Germany, 1740-1757. An 11-by-14 inch print of this illustration with bearings and lettering omitted is available on request on company letterhead.

In today's business dealings (as in yesterday's "affairs of honor") both parties are protected by an intangible factor known as INTEGRITY—a figurative handsake between producer and consumer. Today, this point of honor assures you that the product you buy is exactly as represented. When you write COMPO Oil-Retaining Porous Bronze Bearings into your specifications you find that it is a point of honor with Bound Brook, as a reliable manufacturer, to provide you with the best powder metallurgy bearings that can be produced.

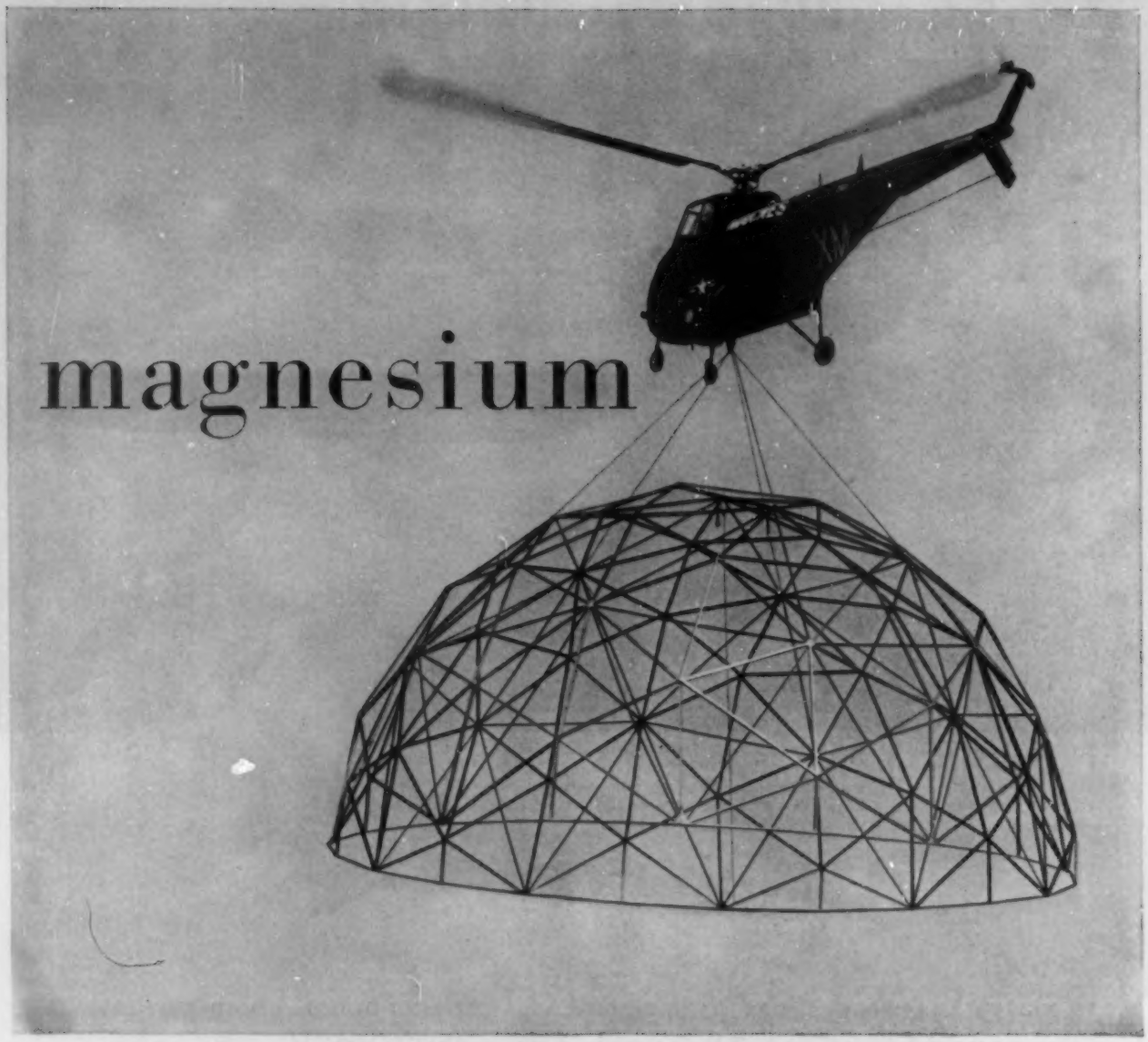
BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

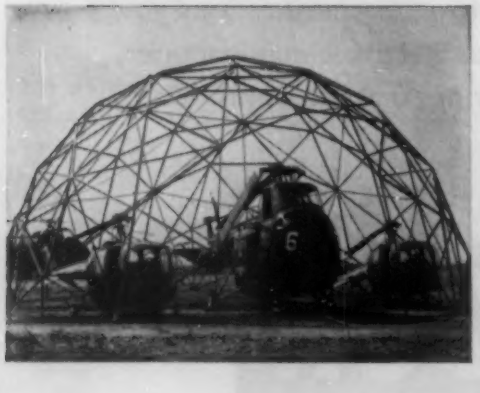
POWDER METALLURGY BEARINGS + PARTS

DOW



airborne hangar for the Marine Corps

. . . *made of Magnesium*



The U.S. Marine Corps called for a very particular metal for the framework of a very unusual "flying hangar." This metal had to be:

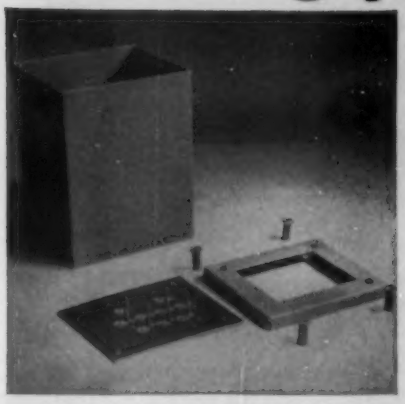
- Light enough to be carried, completely assembled, by a helicopter.
- Strong enough to withstand the repeated takeoffs and landings.

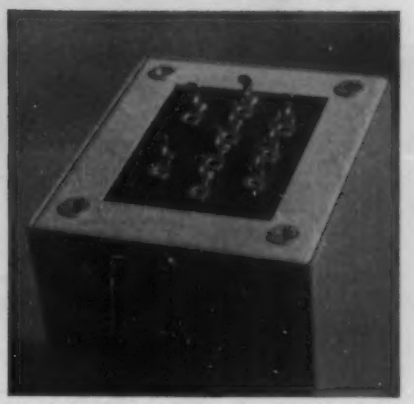
Magnesium, with its high strength/weight ratio, was the answer. Matter of fact, magnesium is appearing in more applications every day where light weight and simplified design are important.

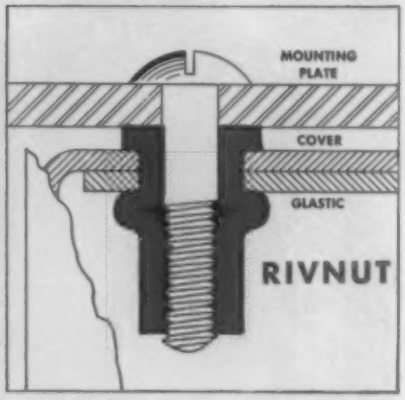
Follow the Marine Corps—take a new look at magnesium! Call your nearest Dow sales office for more information or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. MA-313B.

you can depend on DOW MAGNESIUM DOW

One B. F. Goodrich Rivnut does two fastening jobs to save time, money







In transformer assembly, Rivnuts fasten glastic to metal cover; also serve as mounting lugs.

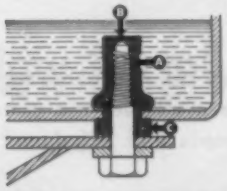
B. F. GOODRICH RIVNUTS cut costs and speed assembly because (1) they fasten materials together; (2) they provide a firm, accurate nut plate at the same time. And they do both jobs in one quick operation! Welding, tapping and clinching are eliminated. Rivnuts can be installed from one side and take an attachment bolt from either end.

The photographs at top show how B. F. Goodrich Rivnuts simplify assembly of transformers made by the SNC Mfg. Co. Starting with unassembled parts, one worker fastens the sheet of glastic to the metal cover with Rivnuts in seconds. With the cover secured to the frame, the Rivnuts then serve as mounting lugs for holding the completed transformer in place on the mounting plate.

B. F. Goodrich Rivnuts have cut costs by speeding up thousands of fastening jobs. Whatever your fastening problem, they can probably do the same for you. Get more information or engineering help by writing: The B. F. Goodrich Company, Dpt. PE-105, Akron, Ohio.

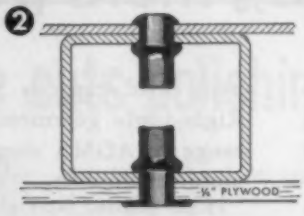
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS

❶



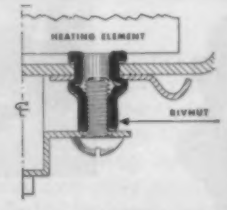
ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.

❷



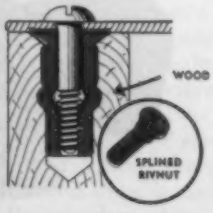
FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

❸



ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.

❹



GIVES 6 CLEAN THREADS IN WOOD! Special Rivnut for solid fastening in wood eliminates wood screws, provides 6 metal threads for attachment bolt. Bulge formed by upsetting holds Rivnut fast. Splined shaft keeps it from turning.

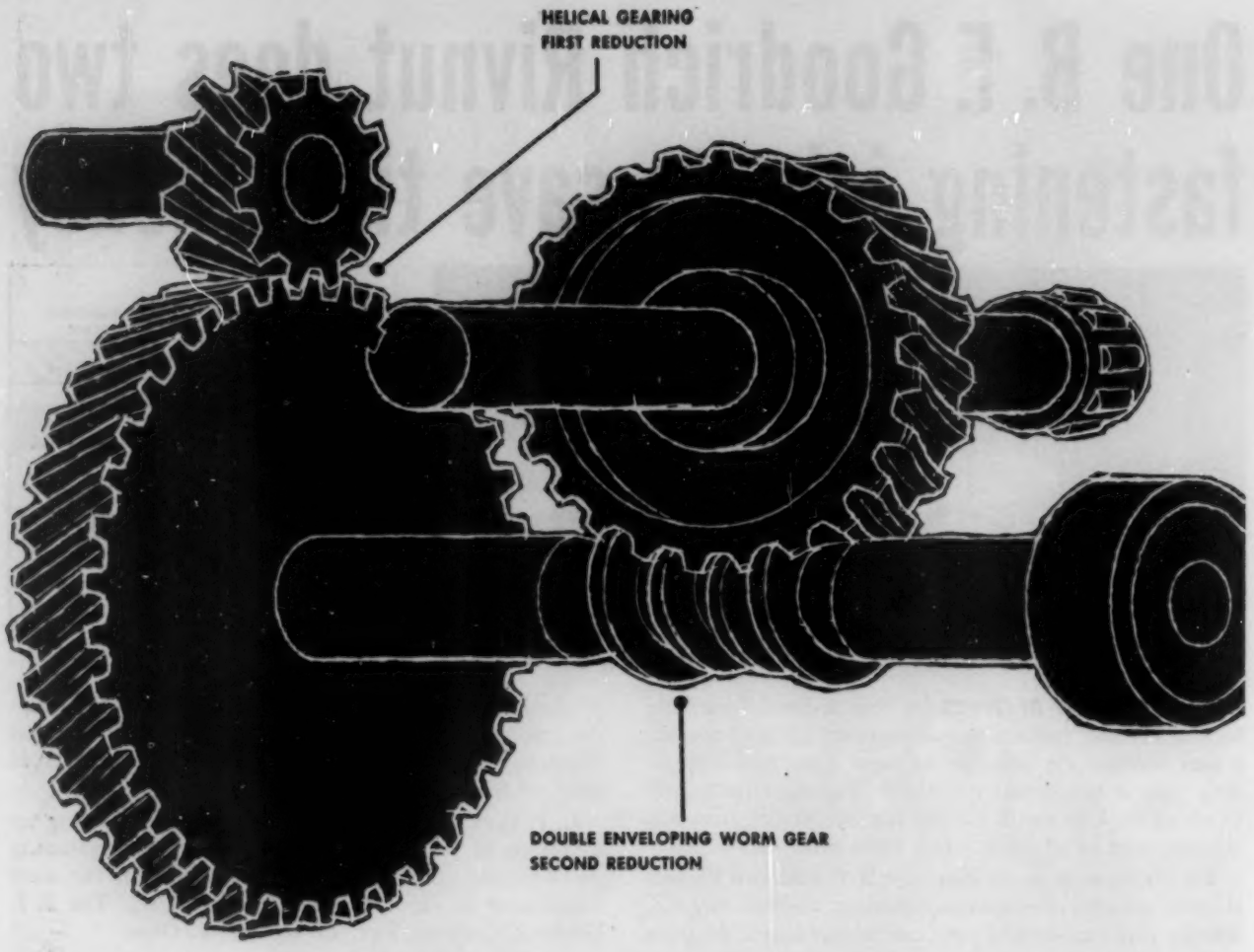
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department PE-105, Akron, Ohio.

B.F.Goodrich

RIVNUT

The only one-piece blind rivet with threads



How Westinghouse new right-angle gearmotor delivers 32% more power

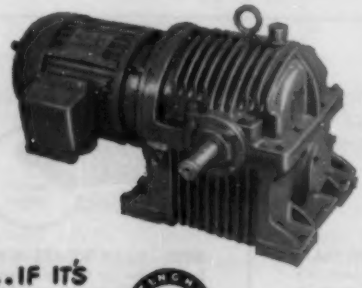
With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

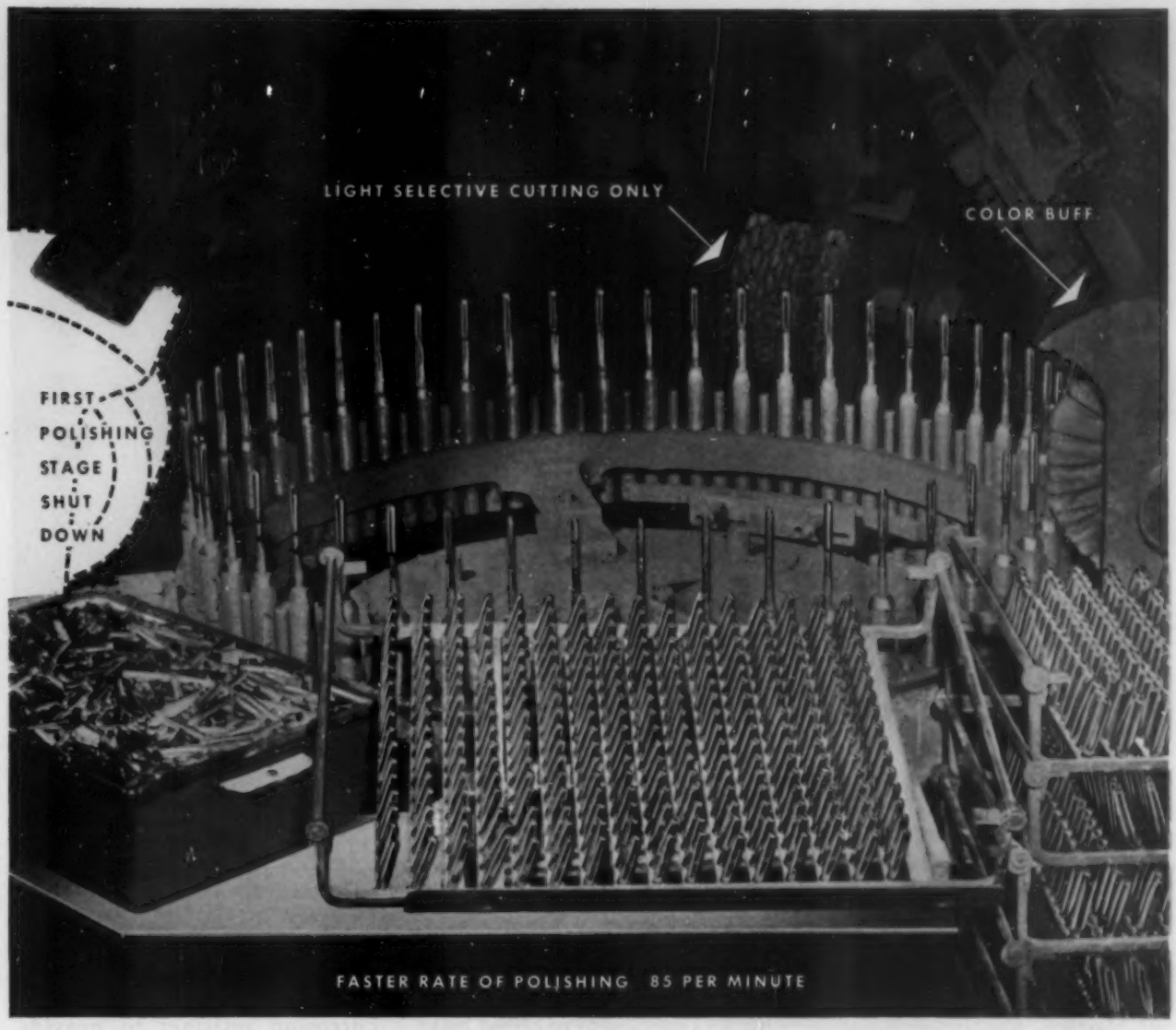
FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-07349



YOU CAN BE SURE...IF IT'S

Westinghouse



How Formbrite cuts polishing costs 40% for JARCO

Pens, pencils, and lipstick cases have to be attractive to sell—yet they must be able to take a beating in daily use. The Jarco Metal Products Co., which specializes in drawing metal parts for these and such other products as miniature flashlight cases, and similarly formed products, tried Formbrite,® Anaconda's new drawing brass, shortly after it was announced to the trade.

Superior polishing characteristics combined with excellent drawing properties, plus hardness and scratch resistance, sounded ideal for Jarco products. Formbrite has proved an excellent pressroom material. The uniformity of temper from batch to batch eliminated shutdowns for adjustments in their battery of 12-plunger Waterbury-Farrel presses, which can produce up to 500,000 pieces a day.

It's in the polishing room where Formbrite has really paid off. Jarco uses 50- and 98-spindle continuous-loop machines having two cutting stages and a final color buff stage. The first cutting stage is shut down completely. The second stage is used for only a partial or selective cut in certain areas of the cap – because of the extremely deep draw. The color buff stage does most of the work. The savings in polishing run about 40%, according to David Roberts, vice president.

Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine grain, excellent drawing properties, strength, and scratch resistance can help you make a better product at lower cost. Write for Publication B-39. Better yet, ask about a sample or a trial batch. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Formbrite
FINE-GRAIN DRAWING BRASS
an ANACONDA® product
made by
The American Brass Company

2 Stainless Parts...

made to the same specs... *but what a difference!*

Tool life increases 33%

This shaft winds the main spring that powers parking meter clocks. When produced from ordinary Type 303 Stainless, machinability was a constant problem . . . tool life was short. Then the company made just *one* change—to Carpenter Stainless No. 8 (Type 303). Now machines run ⅓ longer before tools have to be removed for resharpening.

Unit costs go down

In addition to the savings gained by longer tool life, the uniform, free-machining qualities of Carpenter No. 8 (Type 303) have helped make this job more economical. Now, material can be run at a higher speed. Close tolerances are more easily held.

Top corrosion resistance obtained

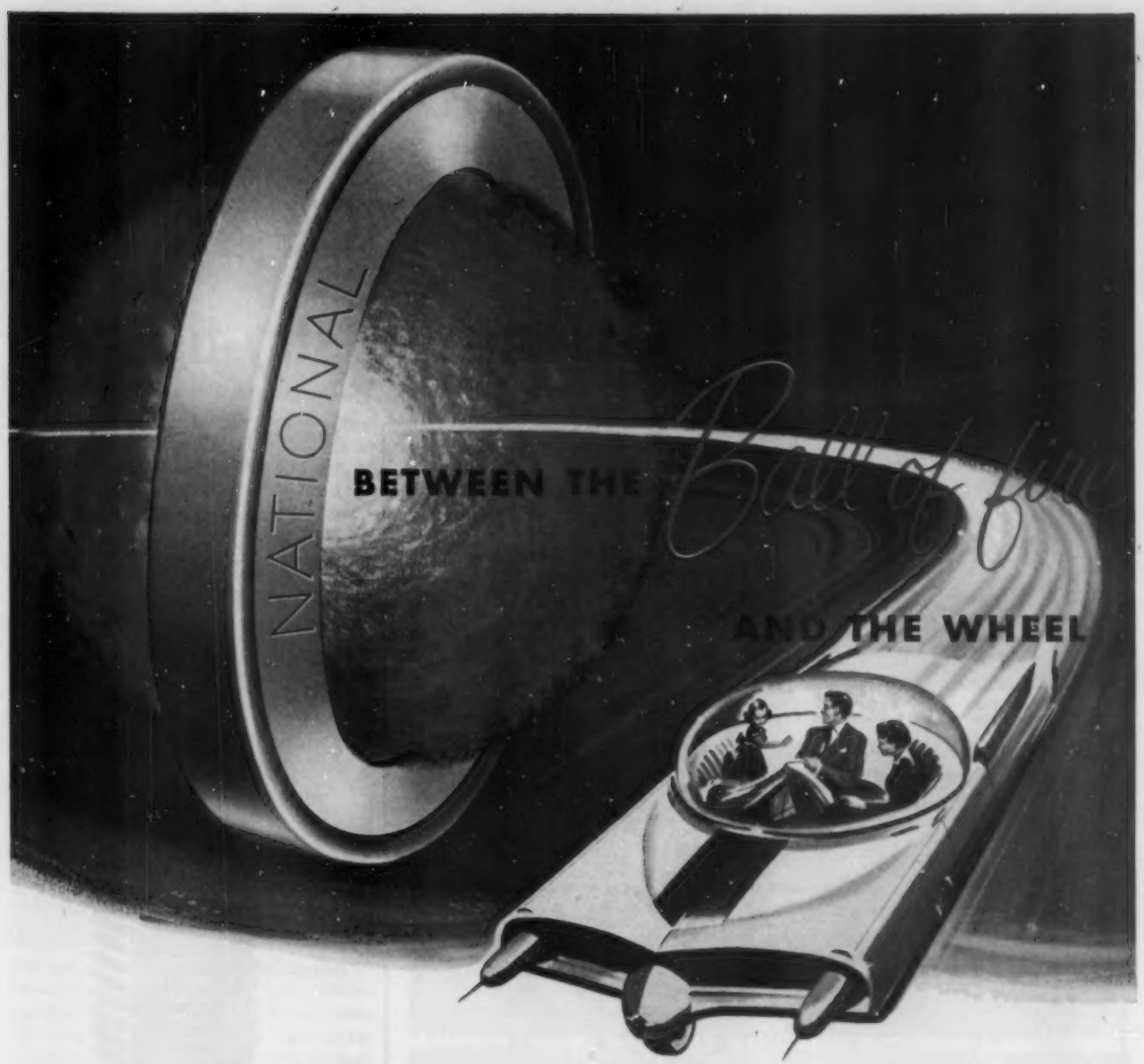
Although machinability was the prime factor for changing to Carpenter No. 8, the shaft had to be corrosion resistant to provide dependable performance when exposed to varying atmospheres in all parts of the country. And Carpenter Stainless No. 8 assured this property.

This is just one example where the difference in Carpenter *quality* and dependability pays off. It's a difference that can add up to speed, performance and profits right in your own plant. See for yourself—specify Carpenter on your next order for Free-Machining Stainless.

take the problems out of production

. . . change to Carpenter STEEL — **Free-Machining Stainless**

IMMEDIATE DELIVERY from local warehouse stocks!
THE CARPENTER STEEL CO., 117 W. Bern St., Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"



Motor cars of tomorrow will be swift and silent beyond belief, powered by the mightiest forces man can employ. Perhaps this power is nuclear, perhaps from a chemical fuel. From either will come the "release explosion"—a swirling "ball of fire"—pure energy to be contained, controlled, delivered to the wheels.

Oil seals will shoulder much of the responsibility. Besides sealing dirt out and lubricant in, seals will serve as air, fuel and even pressure seals. They must withstand shaft speeds to 60,000 rpm at pressures of 60 psi and temperatures to 500°.

National Motor Bearing's advance engineering program for the future brings about many "years ahead" developments in National products of today.

Sealing Achievement! New NMB Sealed Journal Box Kit* converts standard journal assemblies in freight cars to sealed bath lubrication. This recent development virtually solves the 100-year-old railroad "hot box" problem. It can eventually save railroads over $200 million annually. *Pat. & Pats. Pend.

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California. Sales Offices: Chicago, Cleveland, Dallas, Detroit, Downey (Los Angeles County), Indianapolis, Milwaukee, Newark, Van Wert, Wichita. Plants: Redwood City, Downey and Long Beach, California; Van Wert, Ohio.

NATIONAL OIL SEALS ®

New High-Torque Unbrako self-locking socket set screws

set them, forget them—they stay tight

Up to 40% higher tightening torque—a new Unbrako feature

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (Inch-Pounds)

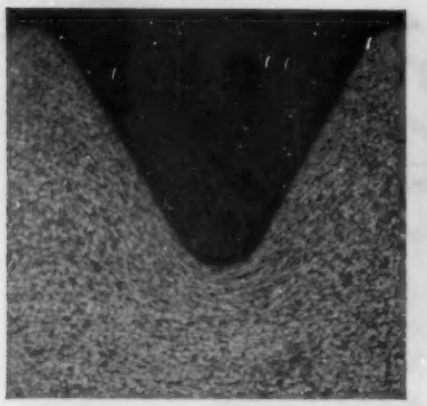
SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

All UNBRAKOS can withstand higher tightening torques than ordinary set screws. For example, the recommended torque for a ¼" UNBRAKO is 87 inch-pounds —40% greater than that recommended for an ordinary set screw.

Research has proved that the tighter you seat a set screw the better it works. We went to work to design a socket set screw that could be tightened tighter than ever before without damaging the screw.

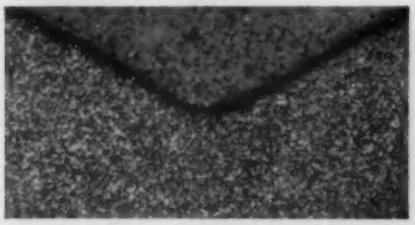
We formed a deeper socket. We put a radius in the socket corners. We developed fully formed threads. We established new methods of heat treatment in atmosphere-controlled furnaces. It took almost 6 years' research and development, but the new High-Torque UNBRAKO incorporates all of these improvements. And it retains the self-locking knurled cup point that keeps an UNBRAKO tight up to 48 times as long as a plain cup point set screw, regardless of the size of the point or the cup.

UNBRAKO SET SCREW



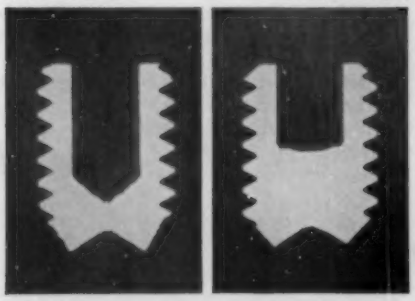
We fully form the threads—make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see in this illustration. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

UNBRAKO SET SCREW



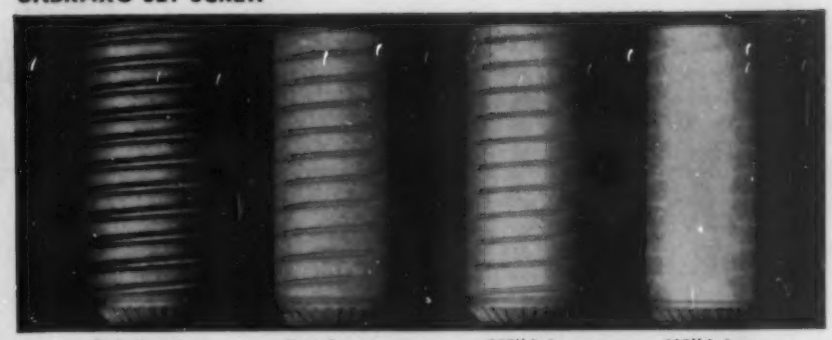
We put a radius in the socket corners—eliminate the sharp corners where cracks start. This distributes the stresses developed when tightening torques are applied. Ordinary socket screws have sharp corners which often crack when tightened even at lower recommended torques.

UNBRAKO SET SCREW **ORDINARY SET SCREW**



We form a deeper socket—give you more purchase with the wrench. Since more wrench can be put into the UNBRAKO socket, you can set the screw much tighter. And you won't ream the socket or round the corners of the wrench.

UNBRAKO SET SCREW



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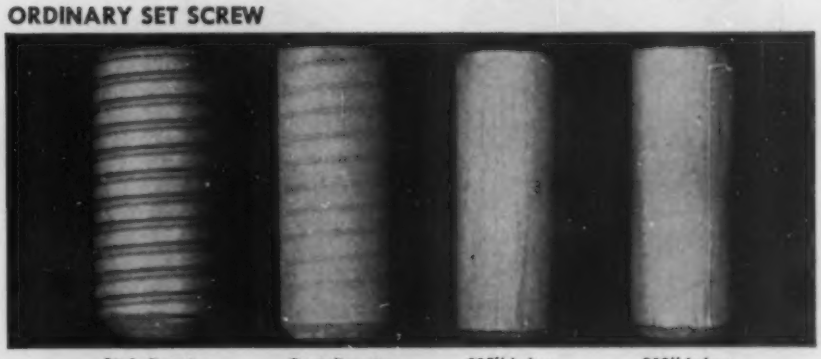
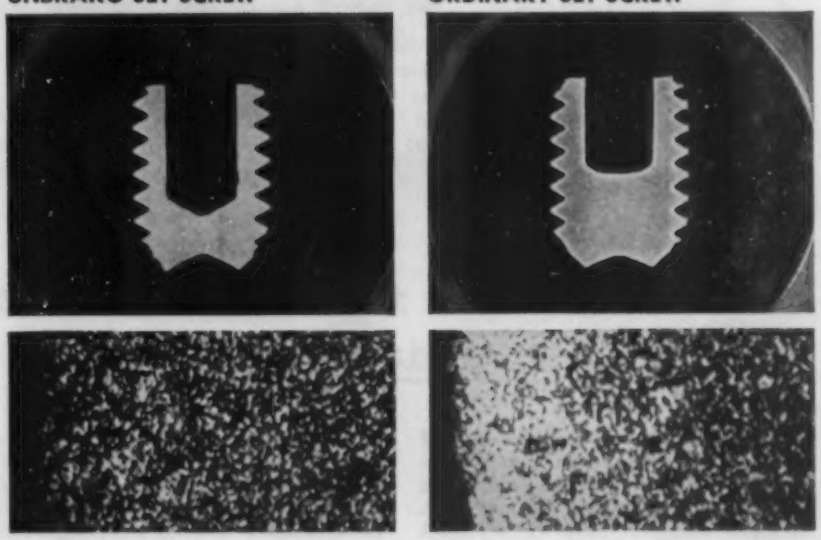


UNBRAKO SET SCREW **ORDINARY SET SCREW**



We heat treat an UNBRAKO properly. It's a ticklish job to heat treat a socket set screw. If you don't do it just right, you get decarburization. And decarb plays havoc with a screw. Put a wrench in the socket and you ream it. Run the screw into a tapped hole and you strip its threads. Try to seat the screw and its point shears off. These photos show the good and the bad. The UNBRAKO is clean. Its grain structure is uniform. There is no decarburization—the ordinary screw is suffering from an overdose of it, socket walls, threads and point are full of the telltale white spots.

You can't buy another set screw as good as an UNBRAKO. See your authorized industrial distributor today. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

STANDARD PRESSED STEEL CO.

UNBRAKO® SOCKET SCREW DIVISION SPS JENKINTOWN, PENNSYLVANIA

A SYLVANIA SPECIALTY "EXTRA FINE" WIRE

To assure high quality fine wire, many tests are made by Sylvania. Elaborate testing equipment includes this Instron machine which records yield and tensile strength and elongation characteristics.

Get "extra fine" diameter wire with the special properties you want

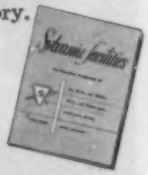
Sylvania is your source for special wire, cold drawn from .250 inch to extra fine diameters of .001, drawn on high speed machines through diamond dies. To insure uniformity, fine wire is strand annealed under carefully controlled temperatures in a protective atmosphere.

Drawing wire in any size from .250 to .001 inch diameters is just one of the reasons Sylvania is a major producer of quality wires. If a wire with special properties can improve product design or cut production costs, Sylvania can produce a composite "made to order." Your composite can be clad or plated in just about any material. You can count on Sylvania to develop the composition wire that best fits your application. Standard plating range varies from "Flash" to 20% by weight. Typical composite wires being produced currently on a custom basis include: nickel on brass; copper on steel; silver on copper; and nickel on steel. There are many others.

Sylvania can also furnish wire flattened to size ⅛" wide or less, and with a knurled surface if desired. Many cross-sectional designs can be rolled, such as half-round and channel shape.

Consult Sylvania on your next special-wire problem—whatever the nature of your product.

New—Wire Facilities Brochure—gives full details on Sylvania's wire and ribbon production story. Write Dept. K33S.



PARTS DIVISION metal stamping · special wire · molded plastics · precision dies

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
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In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, Montreal

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

DOW CORNING CORPORATION

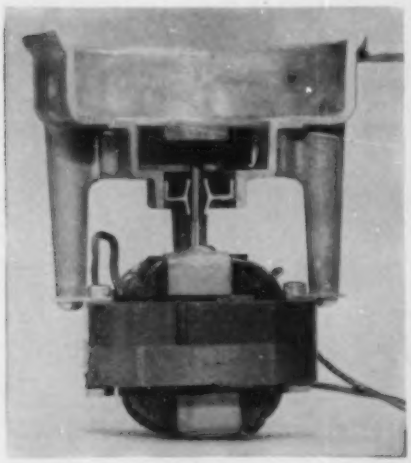
Silicone News

FOR DESIGN ENGINEERS No. 20

SILICONE COMPOUND IMPROVES PERFORMANCE OF DISHWASHER

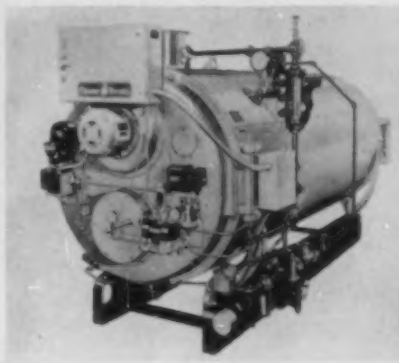
Westinghouse engineers have improved the performance and increased the service life of their dishwasher pump through the use of Dow Corning 11 Compound. Important in this application are heat stability plus good lubricating and sealing properties.

For maximum efficiency, the 3400 rpm pump motor in this dishwasher is direct-connected to an impeller which pumps wash and rinse water from the tub to the drain system. A critical part of the assembly is the rubber-like lip seal that prevents water from leaking down the shaft to the motor.



The dishwasher is designed to heat water if the available water supply is below the required temperatures. This creates high temperatures in the pump area. At such elevated temperatures, the original lip seal lubricant deteriorated quickly permitting the seal to operate "dry" and wear itself out.

Three years ago Westinghouse started to use Dow Corning 11 Compound as a lubricant and sealing material with these results: Service life of lip seals has increased 300%; a watertight seal is more easily maintained because the silicone compound acts as a water repellent seal itself. Although Dow Corning 11 costs more per pound than the lubricant used previously, the cost per unit is insignificant because so little compound is required. *No. 198*



EASY TO APPLY, SILICONE-BASED PAINTS LAST LONGER; HAVE MORE SALES APPEAL

Product designers have found that silicone paints and enamels are more durable than organic finishes and improve the appearance and increase the life of surfaces exposed to high temperatures, weathering and corrosive atmospheres. Among typical consumer product applications are space heaters, heated glass serving trays, incinerators and kitchen ranges. Industrial uses include engine manifolds, exhaust stacks, steam boilers and Class H electrical equipment.

Silicone Finishes Are More Durable

New silicone-based paints give more durable surface protection; air dry rapidly and cure in service to reduce the cost of finishing steam boilers made by the Cleaver-Brooks Company of Milwaukee.

Even the best organic finishes quickly failed and peeled at the normal operating temperatures of Cleaver-Brooks new "CB" line of 15-150 hp, 15-250 psi self-contained boilers. Vitreous enamels were more satisfactory but were much more expensive; required curing at 1200 to 1700 F; and being brittle, were easily cracked.

The solution came in the form of a new modified silicone finish developed by Midland Industrial Finishes. This coating shows no discoloration at temperatures in the range of 600 F, far above the hottest skin temperatures of the boiler.

Only one coat is required. Sprayed on, it air-dries tack-free as quickly as lacquer; cures later, when the boiler is in actual service; and retains its orginal attractiveness and protective qualities for the life of the unit. Cleaver-Brooks report, "the silicone paint provided the best solution we could find to our particular problem."

Silicone Finishes Add Sales Appeal

The inherent heat-stability of a modified silicone-based paint, and the easy cleaning characteristics of the smooth finish, have resulted in a transition from the old familiar black-colored commercial ranges to the sparkling "Granite Grey" models offered today by the Garland Division of Welbilt Corporation.

Garland engineers first proved to themselves that the heat resistance of the silicone-based paint is equal or superior to the old standard black japan paint used on their ranges for many years. Then they began looking for other advantages. They found among other things, that dirt and grease do not adhere as tightly to the silicone-based finish. In addition, the bright, sparkling light colored finish has a good psychological effect—it leads to more frequent cleaning. Garland sums it up by saying, "The silicone-based paint stays young longer."

The modified silicone finish, Glidden's Nubelon, has now been in use for over two years. Before application, the metal is given an alkali wash with a phosphoric rinse. After spraying, the paint is baked 45 minutes at 450 F. *No. 199*

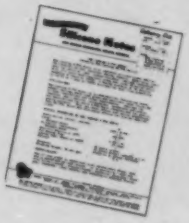
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

Silicone News

DOW CORNING CORPORATION

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Silicone products most widely used, are indexed by type of application, in the 1955 Reference Guide to Dow Corning Silicone Products. A brief but comprehensive 8-page summary is given of the properties and applications. With increasing effort devoted to product improvement and cost reduction, such a reference guide to this remarkably stable group of engineering materials becomes increasingly important to design engineers. *No. 202*

"What's a Silicone?" is the title of a 32-page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 203*

Durable protective coatings made with silicone vehicles include white and colored enamels that withstand temperatures up to 700 F; aluminum pigmented finishes which minimize maintenance of exhaust stacks exposed to corrosive atmospheres and temperatures up to 1000 F; and modified silicone-organic paints that offer greater resistance to temperature extremes, weathering, oils and greases. Source of supply list names more than 60 formulators and suppliers of such protective finishes. *No. 204*

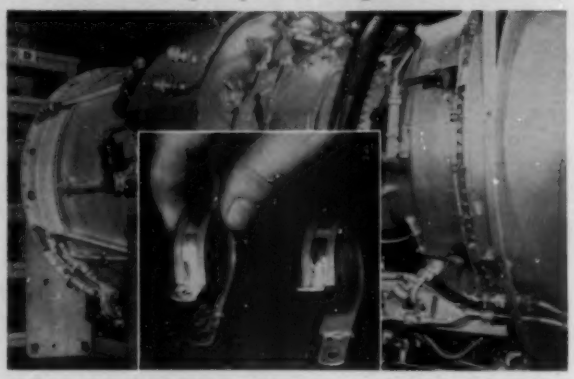
Dow Corning Silicone Defoamers kill foam in a variety of products and processes without risk of contamination. Effective concentrations range from 0.1 to 200 parts per million. Properties and typical applications are described in a new informative reference brochure. *No. 205*

Silicone mold lubricants serve the rubber industry by cutting mold maintenance costs as much as 80%; reducing rejects; improving surface finish and detail of rubber parts. Booklet describes properties, performance and application of all types of Dow Corning silicone mold lubricants. *No. 206*

Silastic, the Dow Corning silicone rubber, keeps its shape, stays resilient from —100 to 500 F; resists hot oils and chemicals; withstands weathering ozone and corona; and is an ideal dielectric material. Properties of Silastic are fully detailed in new reference brochure. *No. 207*

Clamps Lined with Silastic Simplify Jet Engine Assembly

In building the B-52, B-47 and KC-135, Boeing cuts assembly costs and protects tubes and wires against wear due to vibration by attaching them to the engines with clamps cushioned with Silastic*, the heat-stable Dow Corning silicone rubber.



The Silastic liners in these new clamps made by General Metals Corporation, Adel Division, Huntington, West Va., remain resilient even after long exposure to temperatures ranging from —90 to 600 F. They also show high resistance to moisture, ozone and hot oils.

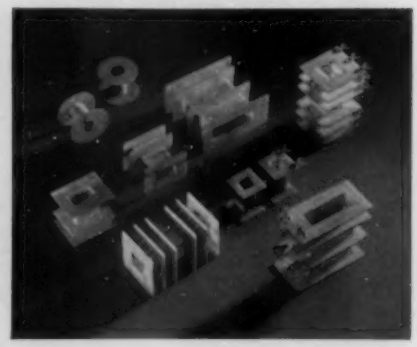
Dielectric strength tests show that these liners retain good dielectric properties for 7 minutes while a flame at 2000 F converts the Silastic to powdered silica. Under identical test conditions, comparable asbestos-lined clamps shorted out in 30 seconds or less.

Wires are quickly gathered into bundles and secured to the engine, saving the time previously required to make or disassemble bundles wrapped with tape. Clamps cushioned with Silastic more than justify their somewhat higher initial cost by savings in installation, maintenance and replacement costs. *No. 200*

*TM. REG. U.S. PAT. OFF.

New Silicone-Glass Insulators Meet Class H Specifications, Are Stronger, Easier to Use

Production methods developed by Silicone Insulation, Inc., New York City, reduce the cost of molding one-piece silicone-glass laminated coil bobbins and other Class H components. Users save assembly costs.



In the bobbins, glass cloth impregnated with Dow Corning 2104 silicone resin flares out from the cores into flanges providing completely unified structures that are easy to handle for quick assembly, and exceptionally strong in proportion to their wall thickness. Tolerances may be held as low as ± .001".

Neither brittle nor flexible, these one-piece laminated Class H bobbins show no tendency to break at the joints, crumble or delaminate. Already in use by several leading manufacturers of high temperature transformers, relays, solenoids and controls, they are available in a wide range of sizes and dimensions, and may have as many as six integral flanges.

Price-wise, silicone-glass laminated bobbins compare favorably with conventional Class H assemblies. Low mold costs permit production runs of as few as one hundred parts. *No. 201*

Dow Corning Corporation, Dept. 8610, Midland, Michigan

Please send me: 198 199 200 201 202 203 204 205 206 207

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones

DOW CORNING SILICONES

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

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RIVETING

as easy as driving a nail!

Southco Drive Rivet Fastening . . . in blind or access applications . . . is quick and economical. One man, with only a hammer, does the job. Just hit the pin . . . the rivet's in. No other operations are needed . . . no bucking up . . . no finishing off . . . no special tools. Time and labor savings are substantial.

Parts are forced tightly together by the rivet's powerful "pull-up".

Spot the fastening applications in your production line that can benefit by the use of Southco Drive Rivets. Let a Southco engineer figure the time that can be saved. There's no obligation. Write for complete information to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

Rivet and Mfg. Patented

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SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

"FINEST CHAIN *for* TOUGHEST DRIVES"

WAYNE-INVADER PUMPS RELY ON ATLAS

...for long life under hard service

Invader Rotary Pumps are workhorses for all industries. That's why the Schirmer Division of the Wayne Pump Company equips all chain-drive pumps, like the oil refining unit above, with Atlas Roller Chain and Precision-Matched Sprockets. They say Atlas is the finest chain for the toughest drives.

Long life starts with Atlas specially selected steels. Plates, pins, and bushings are super-toughened by heat-treating and the "Ni-Carb" process which give a stronger, better operating chain over longer periods. Rollers, pins and bushings are "Micro-Finished" to exact tolerances. Sprockets heat treated for toughness are precision-ground for smooth, quiet operation with Atlas Chain.

Atlas Chain and Atlas Sprockets are carefully pre-tested at more than 30 points in production to assure you of chain unsurpassed in quality and performance. Whatever your chain or sprocket need call on Atlas. Write for Atlas Chain and Sprocket Handbook ARC-54.

ATLAS CHAIN & MANUFACTURING COMPANY
DOYLESTOWN, PA.

ATLAS

ROLLER CHAIN AND SPROCKETS

Drawer liners for **Sears, Roebuck and Co.** "Caravan" furniture are produced by *Panelyte Division*, **St. Regis Paper Co.**, Chicago 41, Ill.

Vacuum-formed impact styrene trays... big selling point at low cost

Here's a design idea that's helping to sell Sears' "Caravan" furniture—drawer liners vacuum-formed from extruded sheets of BAKELITE Brand High-Impact Styrene.

Easy cleaning makes them a hit—notice the rounded corners. The housewife merely wipes these trays clean, though they can readily be removed and washed without harm. Their smooth surfaces don't snag fabrics. Their color complements the natural wood of the drawers.

These sales advantages are inexpensive, too, because vacuum-forming is a fast, economical production method. And BAKELITE High-Impact Styrene TGD-5001 was developed especially for vacuum-forming. Since sheets of TGD-5001 are still glossy after forming, no extra finishing operations are needed. TGD-5001 offers a range of attractive colors, and demonstrates excellent toughness in service.

Learn more about BAKELITE High-Impact Styrenes for extrusion and vacuum-forming. Write today to Department KW-145

BAKELITE
BRAND
High-Impact Styrenes

Visit BAKELITE's exhibit, Booth 1375, National Metal Exposition, Oct. 17-21, Philadelphia Convention Halls, Philadelphia, Pa.

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

The sheet fabricating material that turns designers' dreams into Practical Realities

Is the case, cabinet, cover or other part of your product now made of a material which leaves something to be desired in...

ECONOMY? Royalite economy entails low initial tooling costs and exact, inexpensive prototypes. Tooling may be of wood, resin or metal, depending on the production run. *It's both faster and lower in cost.*

BEAUTY? Royalite's beauty of integral colors, grained or smooth, makes *a more sales-appealing product, eliminates all finishing costs*... another economy.

STRENGTH? Royalite's exclusive compounding of thermoplastic fortified with rubber gives *unequalled wearability and impact resistance.* It may be both *rigid* and tough or *flexible* and tough, as required.

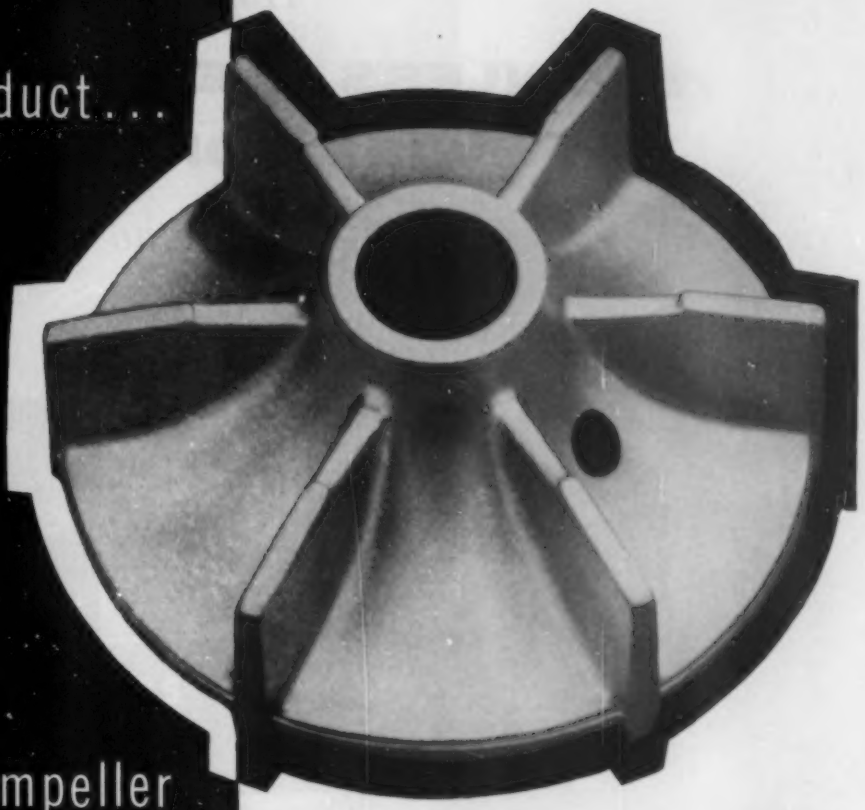
DETAIL? Royalite molds readily to *sharp detail and contour,* giving latitude to the designer.

WORKABILITY? Royalite may be sawed, machined, drilled; bolted, riveted or swedged to metal and other materials.

Economy? Beauty? Strength? Detail? Workability? Only Royalite has them all. Write, wire or phone for full information. United States Rubber Company, 2638 N. Pulaski Road, Chicago 39, Ill.

US RUBBER **United States Rubber**

another case where
MUELLER BRASS CO.
FORGINGS
improve a product...



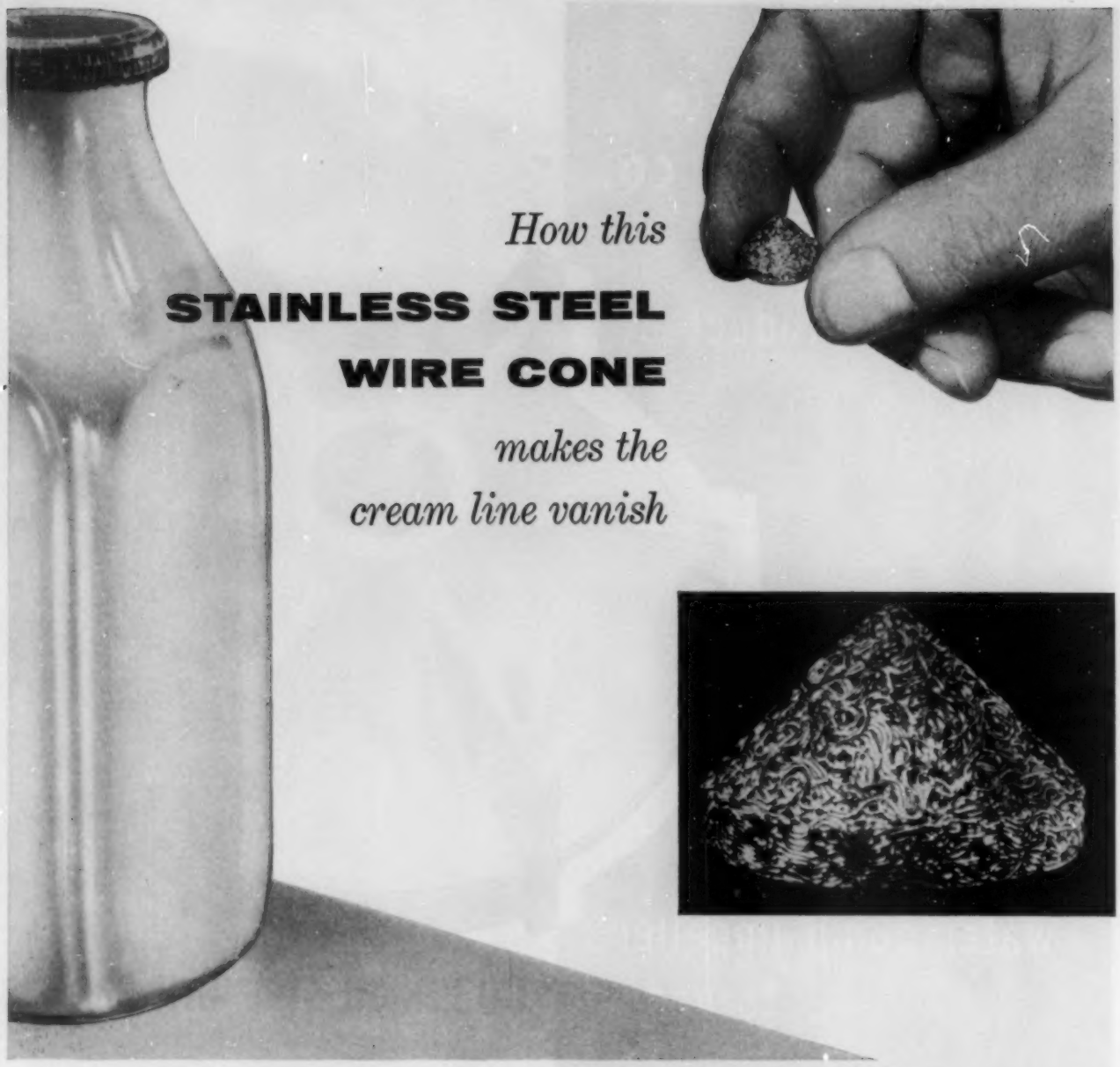
diesel engine
water pump impeller
forged of **"603" HIGH STRENGTH BRONZE**

Formerly produced as sand castings, these impellers now give better results because they're forged from "603" high strength bronze by the Mueller Brass Co. Said to be "right for the job and far superior to the old cast impellers", these forgings bring greater efficiency and longer life to the diesel engine water pumps in which they are installed. This tough "600" series alloy is readily forgeable, possesses remarkable resistance to corrosion, and has fine bearing qualities. Uniformity is excellent, due to the closer dimensional control of the forging process, and surface finish is noticeably smoother. This is another case where Mueller Brass Co. forgings have greatly improved a product . . . why not let our engineers show you the many advantages of using forgings.

MUELLER BRASS CO. STREAMLINE PRODUCTS

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN



How this

STAINLESS STEEL WIRE CONE

makes the cream line vanish

● All of the cream that used to rise to the top of a bottle of milk is still there. But now you can't see it. Homogenizing has permanently blended the cream into the milk.

The heart of a homogenizer is a porous cone formed of crimped stainless steel wire through which the milk is forced at high pressure.

Ordinary wire couldn't take the combination of tight crimping and severe forming without fracturing. And it was too unstable to avoid matting and distortion under the processing pressure.

National-Standard research teams solved each of these problems so that the dairy industry could have better homogenizing equipment. And we stand ready at all times to work on any problem that will give *you* better and more versatile products made from wire, wire cloth or steel strip. Call us and see.

NS
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Tire Wire, Stainless, Fabricated Braids and Tape
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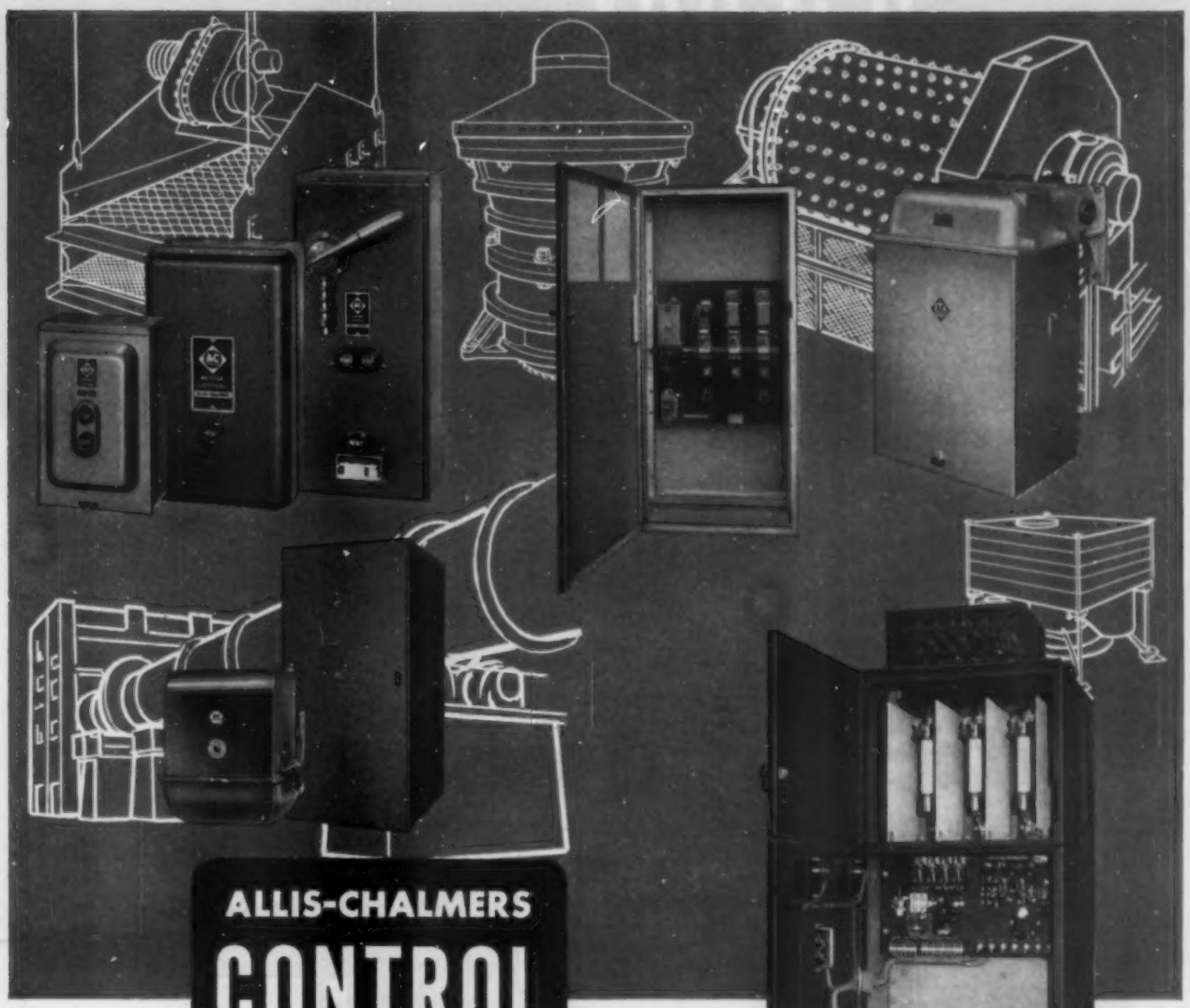

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CONTROL

. . . Backed by Wide Application Experience

As manufacturers of *diversified* industrial equipment, Allis-Chalmers has been called upon to solve control application problems in practically every industry. This specialized experience in coordinating power utilization is *yours* when you specify Allis-Chalmers control.

The Allis-Chalmers line includes control for every condition of motor operation. Functions include full or reduced-voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking. Built into Allis-Chalmers control is the type and degree of protection dictated by the application. Controls are available in general-purpose and special enclosures.

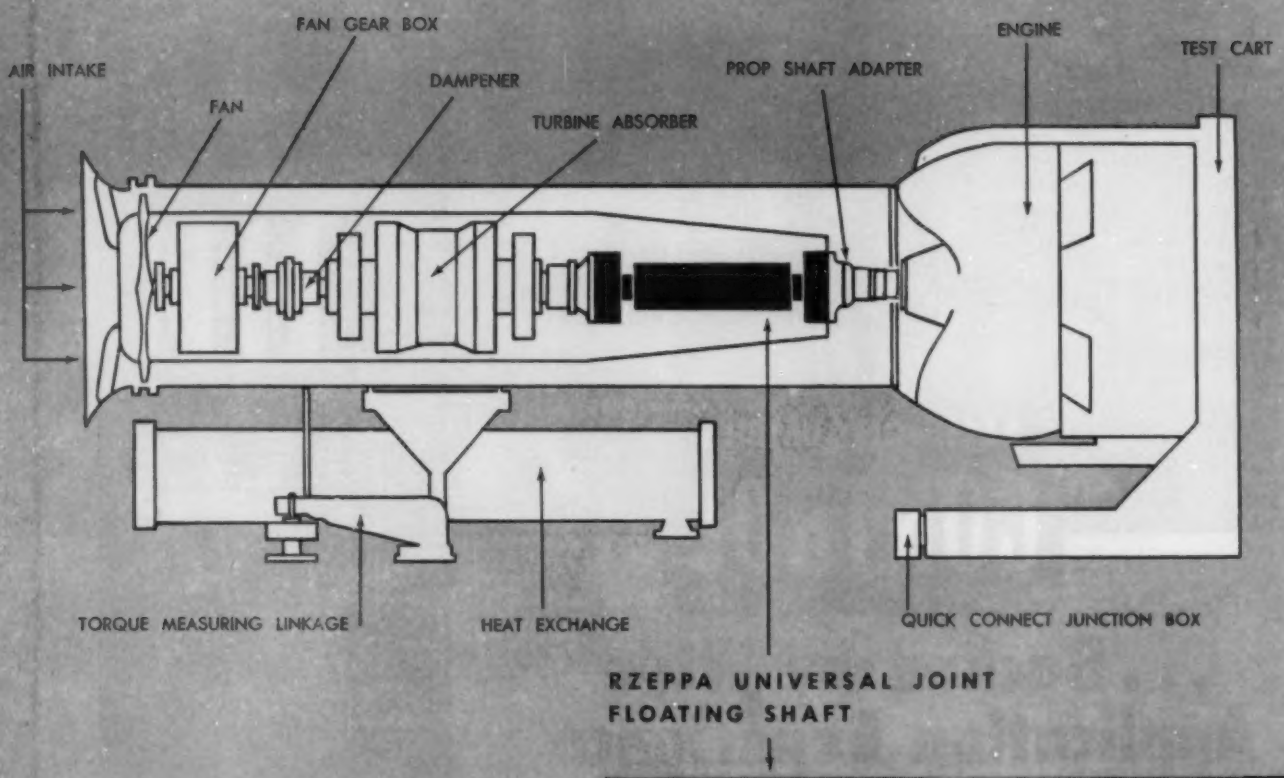
A-4587

● For help on a specific control application, call your Allis-Chalmers representative. His recommendations are backed by Allis-Chalmers engineering departments . . . by experience gained in solving thousands of control problems . . . by complete research and testing facilities.

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Why RZEPPA Universal Joints were selected for first packaged aircraft test facility



ABOVE: The world's first completely packaged aircraft engine test facility, shown in the diagram above, is installed at the Trans-World Airlines Overhaul Base, Kansas City, Kansas. Recently introduced by the Clayton Manufacturing Company of El Monte, California, the unit-built machine includes a turbine power-absorber, engine cooling fan assembly, and floating shaft connecting two Rzeppa Constant Velocity Universal Joints.

The dynamometer, which gives rebuilt engines their final check, eliminates the laborious connecting and disconnecting of test cell procedure. The result: more engines tested per facility.

RIGHT: The huge cone-type universal joint assembly (16¼ inches O.D.) believed to be the largest ever manufactured, is an integral part of the three-unit facility. Specifications for size, precision, constant rotating motion were exacting —and Clayton turned to Rzeppa.

An application where performance really counts

Here's what The Clayton Manufacturing Co. required of a universal joint assembly

1. The assembly, from engine to dynamometer, should not exceed six feet.
2. It must be capable of concentric and parallel alignment of propeller and dynamometer shafts.
3. Universal joint assembly should accommodate angular deflections of ±3°44′ on the propeller shaft end and ±1°40′ on the dynamometer end.
4. Preferred minimum rating of assembly:
   (a) 3500 hp at 1150 rpm
   (b) a maximum speed of 1260 rpm (at 2800 hp)
5. Life expectancy of the joint assembly should be 10,000 hours.
6. Maximum O.D. of universal joints should not exceed 22 inches.
7. Minimum end float of the universal joint assembly shaft should be ±0.175 inches.

Here's how the Rzeppa joint assembly EXCEEDED Clayton's specifications

1. Shaft length between engine end and dynamometer end is *less than* four (4) feet.
2. Rzeppa Joint's constant velocity eliminated alignment requirements.
3. The assembly provides a rating of 5000 hp at 1200 rpm.
4. Has a life of 10,000 hours.
5. Maximum O.D. of joints is 16¼ inches.
6. Shaft float at zero angularity is ±.375 inches minimum and ±0.5 inches maximum.

In addition, Rzeppa offered these advantages:

1. Great torsional stiffness.
2. No vibration.
3. Safe critical speed.
4. A constant torque characteristic.
5. Zero radial forces due to angular operation.
6. Very high efficiency shown by low temperature rise during operation.

How Rzeppa True Constant Velocity Works for you

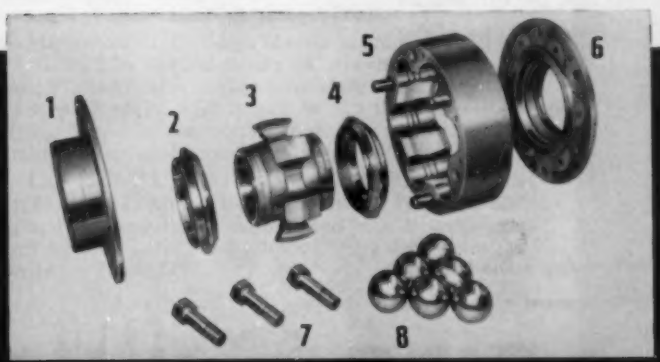
- High Angle Efficiency
- High Capacity
- Ruggedness
- Compactness
- Long Life

The principle of Rzeppa True Constant Velocity has proven itself over a quarter-century in a wide range of industries, for an even wider range of applications. It is this principle which eliminates speed fluctuation and vibration.

Today, low angle-high speed Rzeppa disc type joints are used on power take-off shaft drives on aircraft (up to 3° at 8,000 rpm). High angle-low speed Rzeppa bell type joints permit continuous minors to vary their working angle up to 35° at 400 rpm.

Your joint application lies somewhere between these two. And Rzeppa Constant Velocity Universal Joints offer you more effective performance by transmitting a uniform flow of power. Whether your application calls for disc or bell type, you get a rugged, versatile universal joint—a joint that carries heavier loads for its size than any other type

What joint applications do you have that could use performance advantages like these? Our catalog may help answer that for you. Send for it today



Patented construction principles of the Rzeppa Universal Joint permitted Geargrind to design and construct a joint assembly exceeding the Clayton Company's joint assembly specifications. Exploded view shows (1) outer cover, (2) and (4) piloting rings, (3) inner race, (5) outer race, (6) shaft end cover, (7) mounting and driving bolts, (8) hardened steel balls.

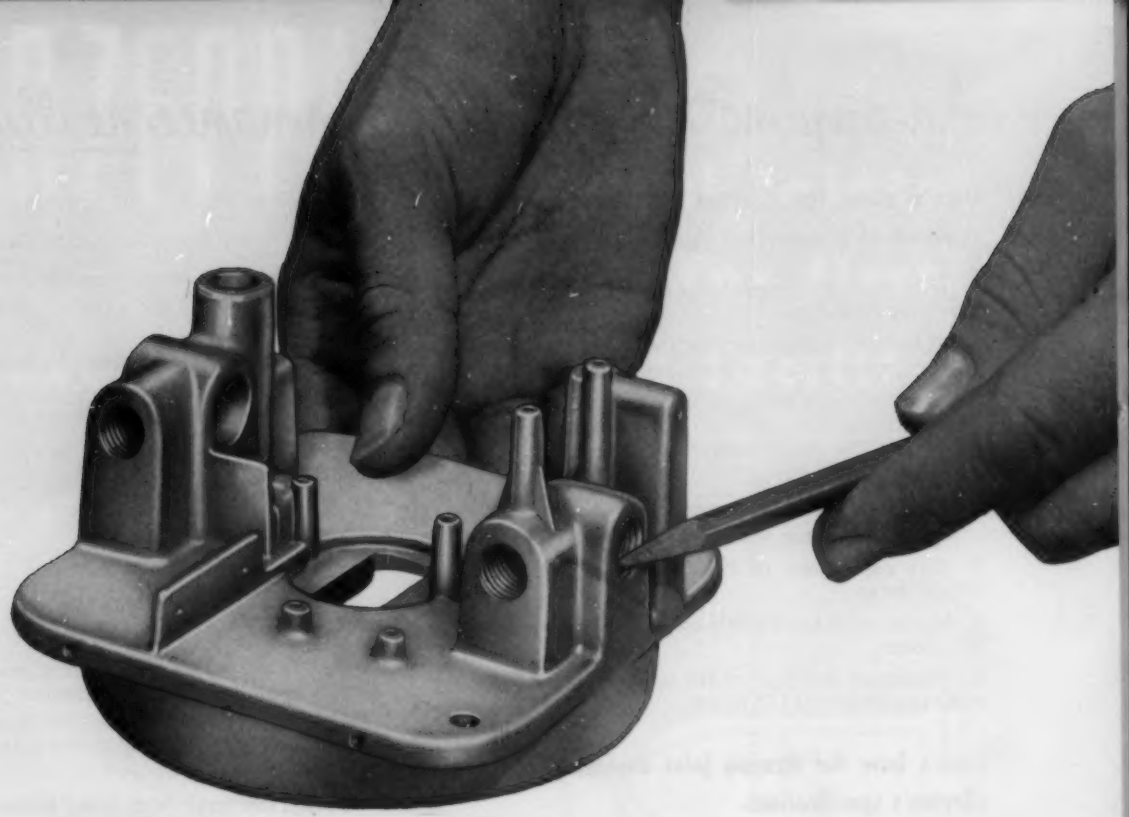
RZEPPA

pronounced "SHEPPA"

Constant Velocity UNIVERSAL JOINTS

JOINT DIVISION
THE GEAR GRINDING MACHINE CO.
3939 CHRISTOPHER, DETROIT 11, MICHIGAN

Manufacturers of:
- Fully Automatic Gear Grinding Machines
- The DETROIT SCREWMATIC 750



complex? yes . . .

costly? no!

● Resourcefulness, plus complete machining facilities, enabled **Stewart** to produce this unusual die casting in volume—economically!

This one kept us awake nights. The job called for an internally cast jar thread and a great deal of precision machining. To speed production and cut costs, we devised a setup that performed 24 separate machining operations *at one time*. Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

45 years of helping industry to "Make It Better"

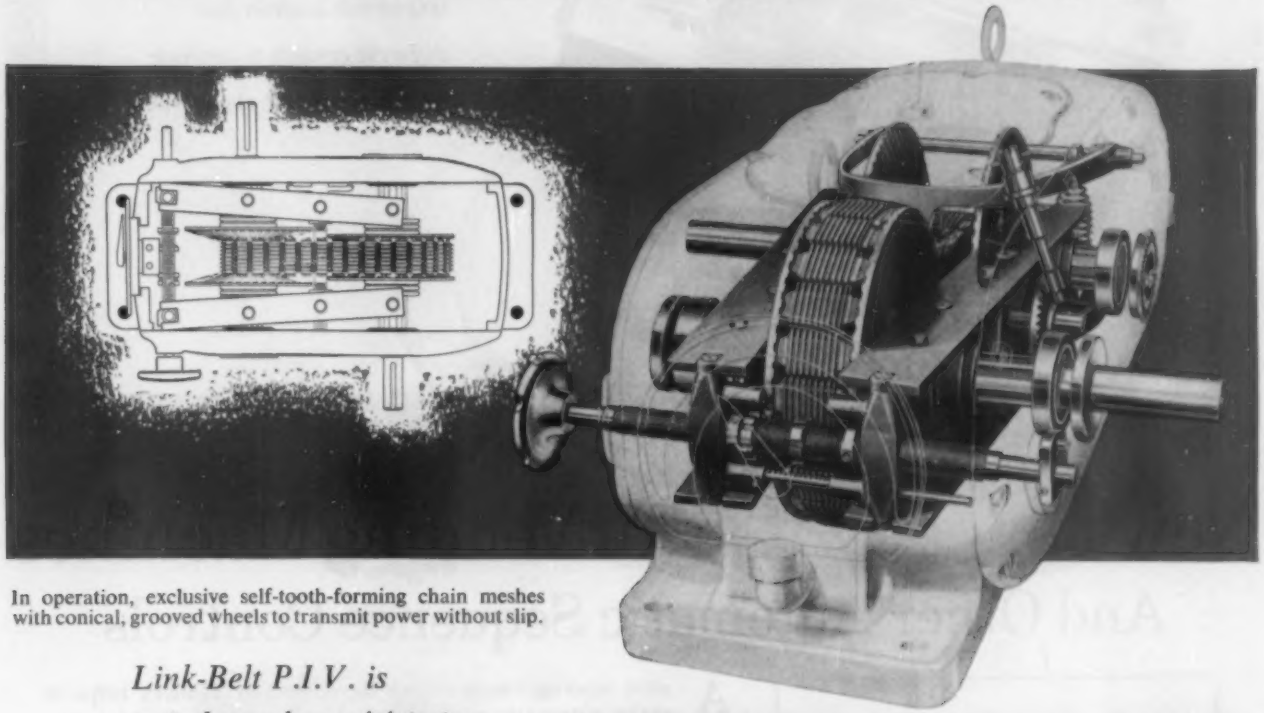
Stewart **DIE CASTING**

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

Looking for the accurate mechanical variable speed drive?

IT'S LINK-BELT P.I.V.



In operation, exclusive self-tooth-forming chain meshes with conical, grooved wheels to transmit power without slip.

Link-Belt P.I.V. is

- *independent of friction*
- *all metal*
- *fully enclosed*
- *automatically lubricated*

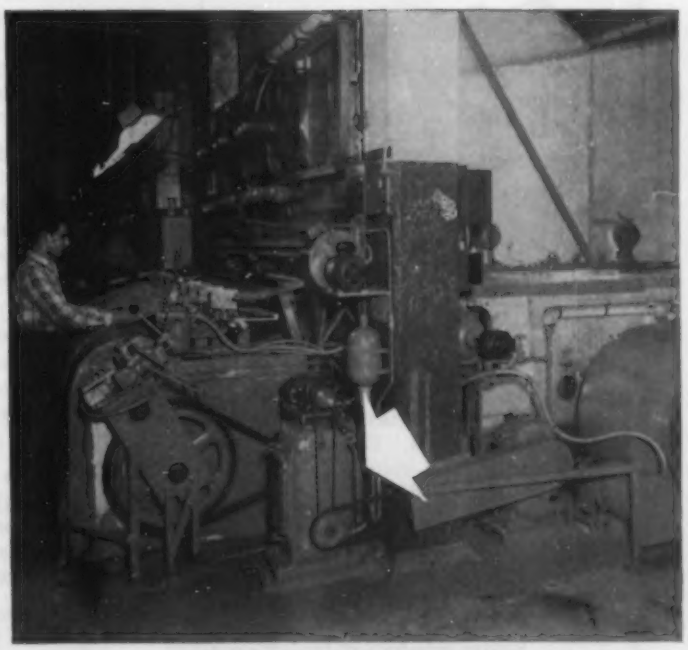
Here is the Positive, Infinitely Variable speed drive that's not dependent on friction for transmitting power. Instead, its exclusive drive chain with self-forming metal teeth engage with radial grooves in two pairs of cone-shaped wheels. Positive power transmission is assured at all speeds regardless of load.

Movement of the single control screw simultaneously varies effective diameters of wheels on input and output shafts. This makes possible an infinite number of stepless speed adjustments within the range of the drive. Speed of the output shaft can be changed instantly, even while operating under full load.

Link-Belt P.I.V. drives are available in capacities from ½ to 25 hp . . . in 8 sizes and 16 types for horizontal and vertical mounting. See your nearest Link-Belt office or authorized stock-carrying distributor, and write for Book 2274.

P.I.V. LINK-BELT

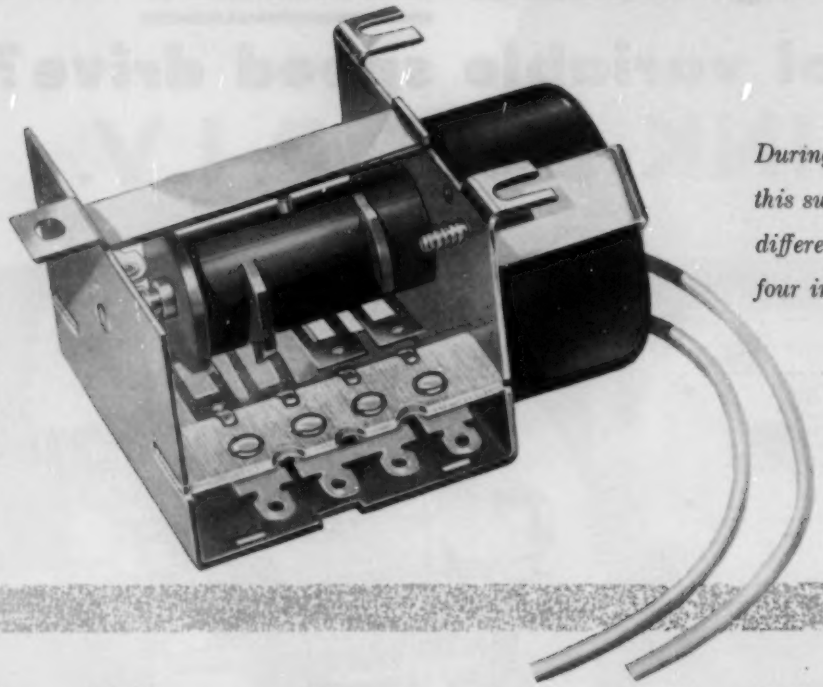
VARIABLE SPEED DRIVE



On jute slasher, Link-Belt P.I.V. Variable Speed Drive with electronic control automatically regulates the speed of winding ends onto the beam by control of the moisture content of the material and the accumulating diameter of the wound beam.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 12,933

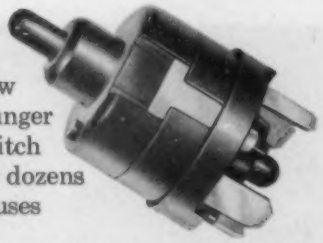
MALLORY



During an eight-second cycle, this switch controls four different circuits to generate four independent operations.

New Timer Switch for Vending Machines

And Other Automatic Sequence Controls



New Plunger Switch fits dozens of uses

A plunger switch, recently developed by Mallory, makes or breaks one or two circuits in sequence—in only ¼" full travel. Actuated by a cam, knob, door or similar device, it provides three different switching points at the released, partially depressed and fully depressed positions. Capacity is 20 amps at 230 volts AC. Only 1½" in outside diameter. Write to Mallory for full information.

A NEW interval timer switch developed by Mallory helps to make automatic vending machines perform varied operations in quick, accurately timed sequence. On a soft drink dispenser, for example, the switch regulates four actions in an eight-second cycle: drops a paper cup into place, opens a valve to fill the cup, shuts off the valve and releases a latch to let the customer receive the cup, then counts the sales.

Four independent circuits can be controlled at varied intervals during the cycle. Other timers can be furnished to control more or fewer circuits. The basic switch action can be supplied in varied lengths of total cycle. It is applicable to numerous other types of automatic vending devices . . . and can be applied to sequence controls in other fields of use such as machine tools.

Approved by Underwriters Laboratories, the switch operates from standard 110-volt, 60 cycle power lines. It embodies the design and construction features which Mallory has developed during years of experience in producing timer switches for leading appliance manufacturers. It is compact in size, and requires minimum labor to mount and connect in your equipment.

Whenever you are designing automatic vending machines . . . or any product which makes use of automatically switched circuits . . . you can profit by the application of this and other timer switches available from Mallory. We will be glad to send data and to have one of our specialists consult on your specific problem.

Expect more . . . Get more from

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
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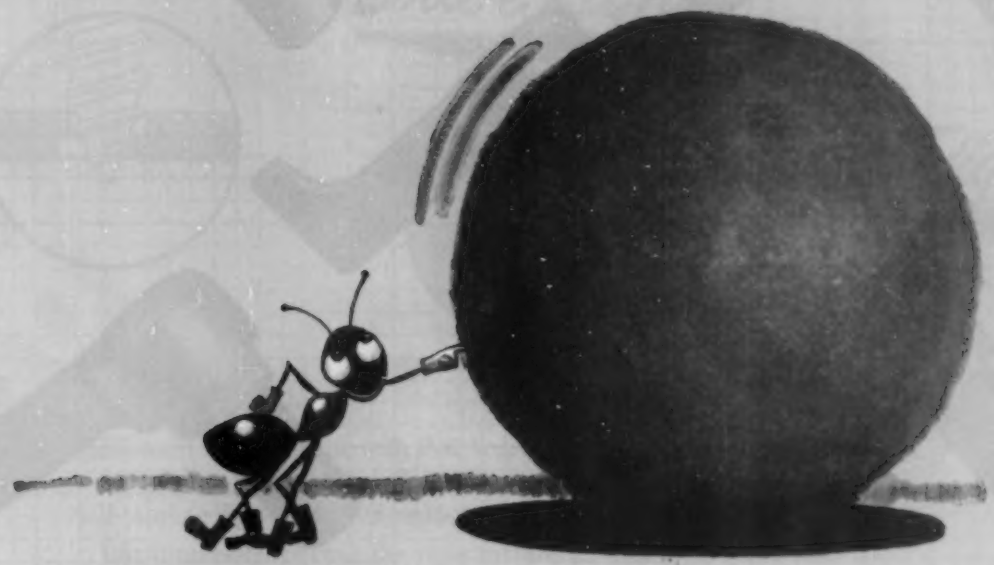
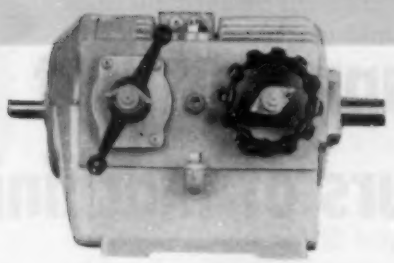
You can get full details in our latest Technical Bulletin. Write or call Mallory for a copy today.

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Highest Torque at Low Speeds...





. . . no oversize power plant needed with the

new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION.

Here's the variable speed transmission that gives you HIGHEST TORQUE

in LOW SPEED RANGE. Find out about this and all of the other exclusive

features offered by GEROTOR in this new transmission. *Write . . . TODAY!*

MANUFACTURERS OF

GEROTOR

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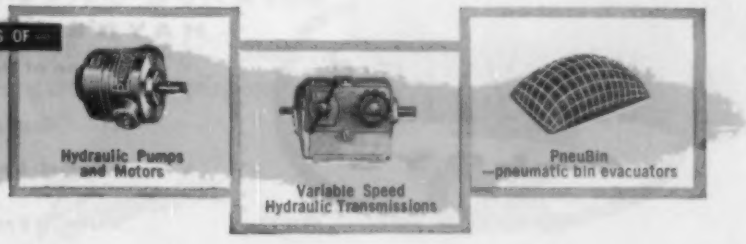
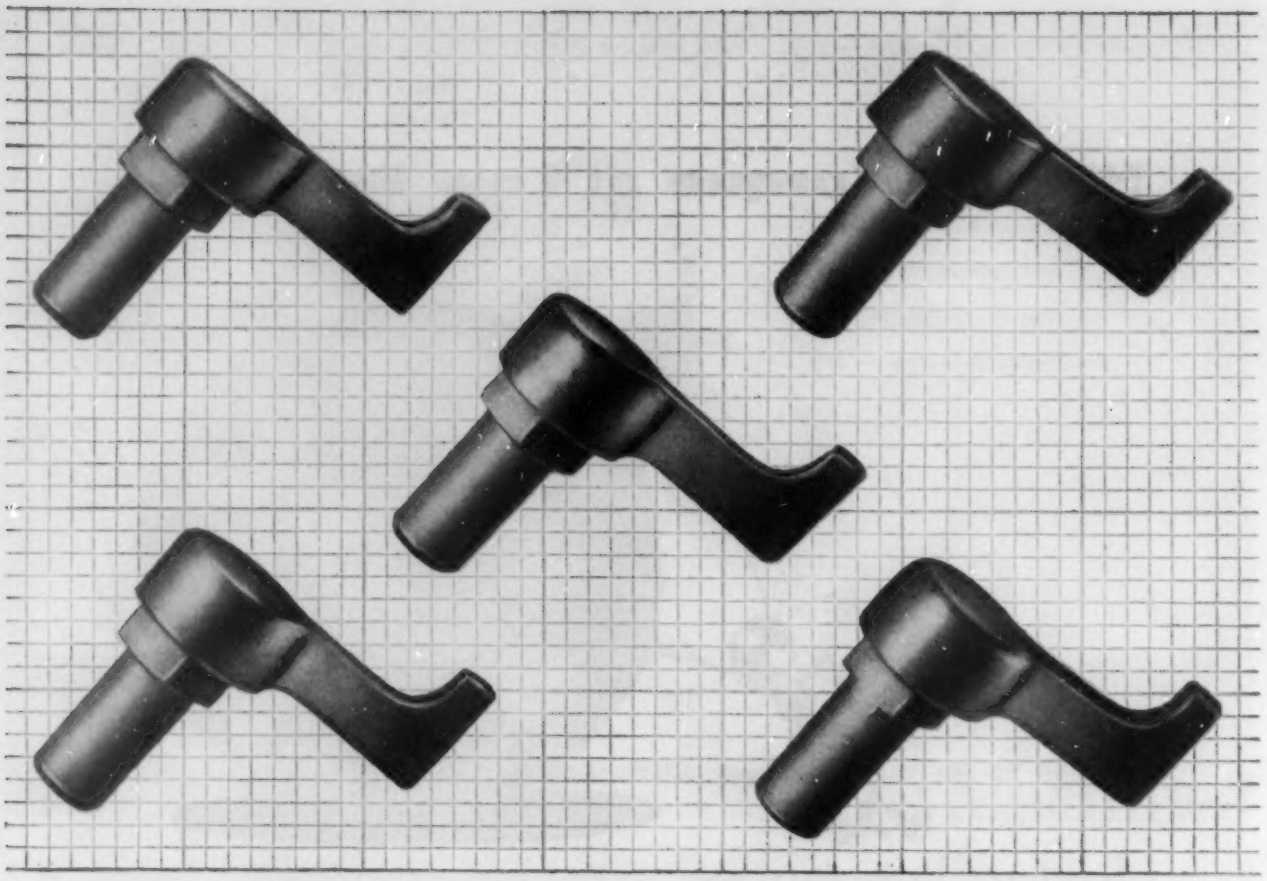
1511 MARYLAND AVENUE • BALTIMORE 3, MARYLAND





Cam Segment—weighs less than an ounce, measures less than ½ inch.

Investment-Casting improves part ... eliminates hours of machining

HAYNES' investment-casting process made it possible to mass-produce a small intricately-shaped part in a hard, abrasion-resistant alloy. The part, a cam segment, is less than one-half inch long, and weighs only a fraction of an ounce. It is cast to size. Only one simple threading operation is required to prepare it for operation.

The cam segment is used in a control instrument and rides against a valve shaft under pressures up to 35 lb. per sq. inch. At one time it was cast from a relatively soft metal and machined to final dimensions. The machining time for each cam was several hours—an expensive operation. The performance of the part was unsatisfactory because the metal used was selected for ease of machining—and could not stand up under the abrasive conditions.

The investment-cast segments are now made of type 410 stainless steel. They have been used for over one million operations and still show no signs of wear.

The freedom to select alloys for performance, regardless of how difficult they may be to machine, is one of the big advantages of HAYNES' investment-casting method. Intricate shapes in hard metals can be cast close to size, eliminating many machining operations. For full details on the process, write to our general sales office in Kokomo, Indiana, or any of the district sales offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

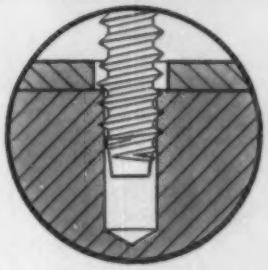
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

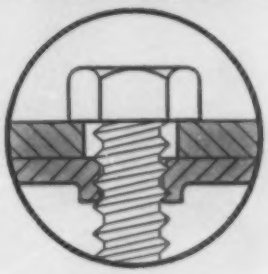
For Self-tapping Screws that...

Start Right

Drive Right



Seat Right



Millions in savings made with P-K Screws since they were originated by Parker-Kalon have proved the Self-tapping Screw *method* reduces assembly costs.

But it takes more than the right method to make sure planned savings pay off. It takes P-K quality standards to guard against defective screws that cause assembly trouble, costly damage to parts, and hidden weakness that shows up in customer complaints.

Only Parker-Kalon can offer P-K quality, the indispensable extra, along with the proved advantages of Self-tapping Screws.

Plan your assemblies for lowest cost . . . a P-K Assembly Engineer will help you. Then make sure *planned* savings *keep on paying off* . . . when you purchase, order "P-K". Parker-Kalon Division, General American Transportation Corporation, 200 Varick Street, New York 14.

Stay Tight

PARKER-KALON®

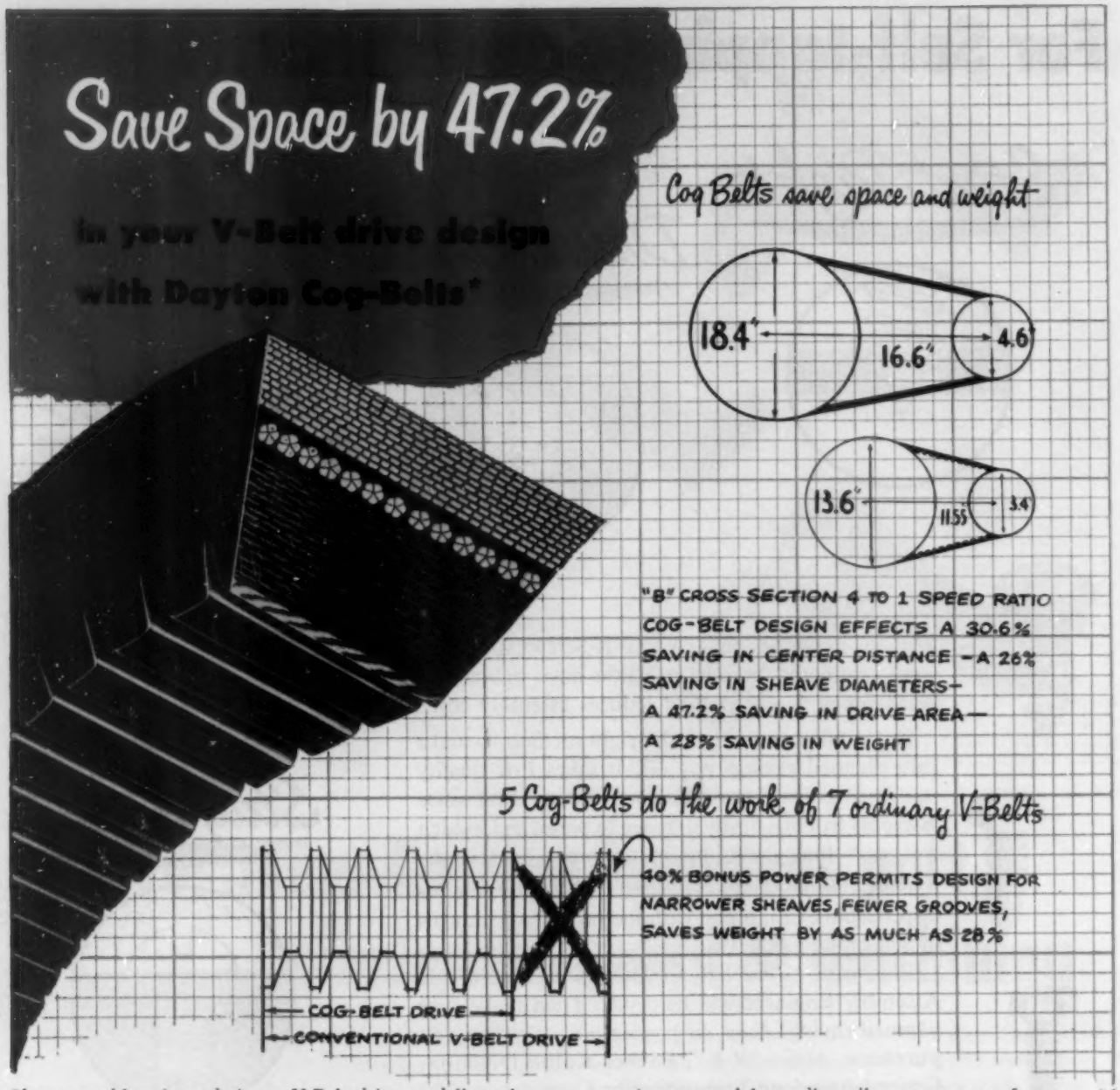
The First **SELF-TAPPING SCREWS**

originated by P-K . . . and *first* today . . .
the leading choice for fastening economy

Remember **P-K** means **OK**

Save Space by 47.2%

in your V-Belt drive design with Dayton Cog-Belts*


Cog Belts save space and weight
18.4"
16.6"
4.6"
13.6"
11.55"
3.4"
"B" CROSS SECTION 4 TO 1 SPEED RATIO
COG-BELT DESIGN EFFECTS A 30.6%
SAVING IN CENTER DISTANCE - A 26%
SAVING IN SHEAVE DIAMETERS-
A 47.2% SAVING IN DRIVE AREA—
A 28% SAVING IN WEIGHT
5 Cog-Belts do the work of 7 ordinary V-Belts
40% BONUS POWER PERMITS DESIGN FOR
NARROWER SHEAVES, FEWER GROOVES,
SAVES WEIGHT BY AS MUCH AS 28%
COG-BELT DRIVE
CONVENTIONAL V-BELT DRIVE

If your problem is to design a V-Belt drive to deliver the *full* power of your product in a limited operating space, yet still get consistent efficiency and long, economical service, you can do it with Dayton Cog-Belts.

You can use smaller sheaves with fewer grooves and shorter and fewer belts. For example, 5 Dayton Cog-Belts do the work of 7 ordinary V-Belts. Besides saving space, you reduce weight and costs.

They offer greater grip, strength, flexibility and heat and static dissipation for power drives characterized by high speeds. They're the perfect answer where short centers, small sheave diameters, continuous operation and excessive external heat, dirt, oil or grease are factors.

For prompt attention, write to: Dayton Rubber Company, Industrial Division, Dept. 875, Dayton 1, Ohio.

Check These exclusive Design Advantages:

1—The Tension Section flexes easily, giving longer life.

2—The Load Carrying Section has maximum stretch-proof strength.

3—The Compression Section has unequalled cross-wise rigidity.

4—Preformed, integral Cogs flex uniformly for full grip.

5—Smooth, die-cut sides assure positive grip, *full* power.

GOLDEN JUBILEE

Dayton Rubber 50 YEARS OF PROGRESS

World's Largest Manufacturer of V-Belts

*T.M.

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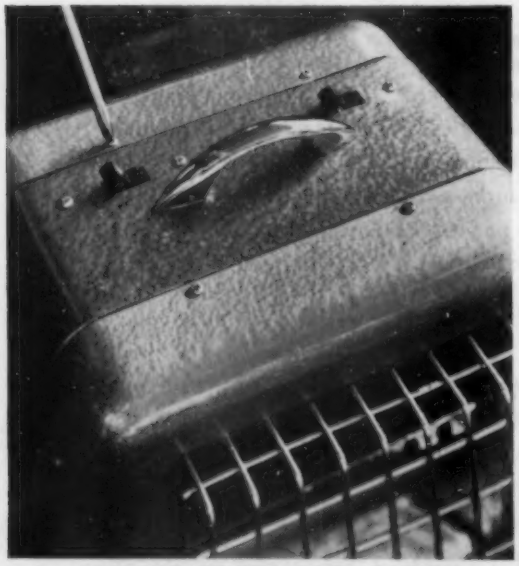
PRECISION ASSEMBLY TECHNIQUES IMPROVED

... with Phillips Cross-Recessed-Head Screws

BIT SLIPPAGE DISAPPEARED with resultant savings in fewer damaged cabinets . . . production time was shortened . . . when the Apex Electrical Company, Cleveland, Ohio started using Phillips screws nearly twenty years ago. "In addition," says the Apex Superintendent of Assembly, "where rust used to result from water under screwheads in washing machines, the extra tight bond of Phillips screws in our units has ended this completely."

LOWER COSTS, HIGHER QUALITY with Phillips screws is true at A. C. Gilbert Company, famous toy manufacturer, also maker of fans and other production items. Phillips screws make angle insertion and tightening easy where single-slot screws caused production headaches. Gilbert's screw buyer states, "Experience with the many advantages of Phillips easy-to-use recess slot is why we plan to use these screws in increased applications."



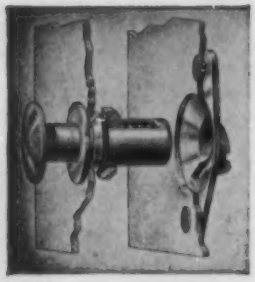
SUPERIOR APPEARANCE AND UTILITY made Phillips screws the choice when Titan . . . now among the top three in the field . . . began making electrical heaters in Buffalo in 1946. A Titan Vice President comments, "We have improved design and production techniques. Reduced damage due to screwdriver slippage . . . reduced tool replacement and time . . . produced a lower priced item. We are definitely a pleased Phillips' customer, and we will continue to be."

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

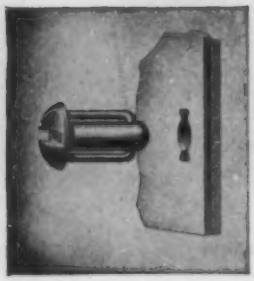
THE FASTENERS OF TODAY...
AND OF THE FUTURE
X marks the spot
the mark of extra quality

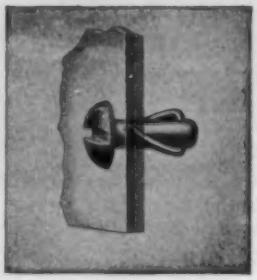
Allmetal Screw Products Company, Inc. • American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company • Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Company Rockford Screw Products Company • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hardware Manufacturing Company Sterling Bolt Company • Universal Screw Company • Wales-Beech Corporation

3 ways to save on assembly costs



QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.





SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. SPRING-LOCK is now available in high-impact plastic. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.

ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

Simmons Fasteners are widely used in refrigerators, washing machines, electrical equipment, electronic assemblies, prefabricated portable shelters, coolers, demountable furniture. Every Simmons Fastener is a service-proved design with a long record of assembly-cost saving in many industries.

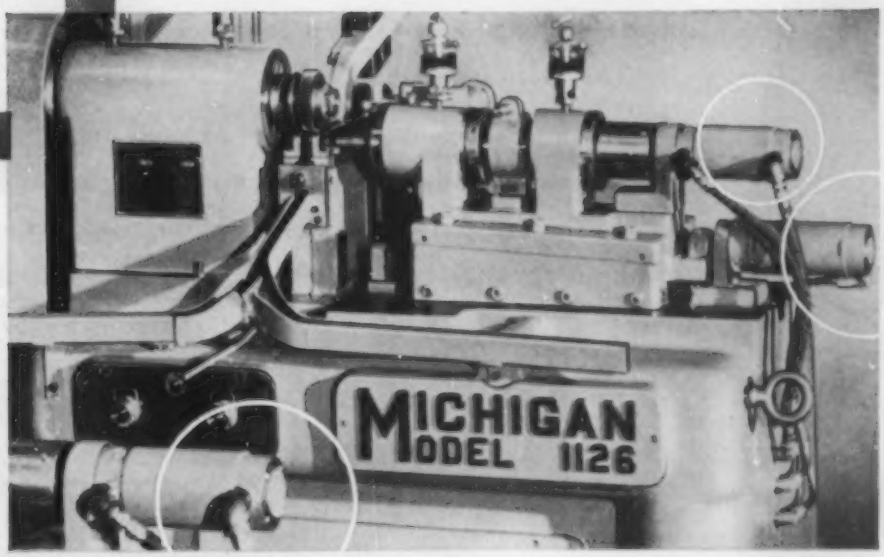
If you are interested in cutting your costs, turn to Simmons Fasteners—the fasteners with *uses unlimited*. Write for samples and catalogs today.

SIMMONS FASTENER CORPORATION
1751 North Broadway, Albany 1, N. Y.

O-M

CYLINDERS
(air and hydraulic)

an important part of the automation picture at MICHIGAN TOOL COMPANY

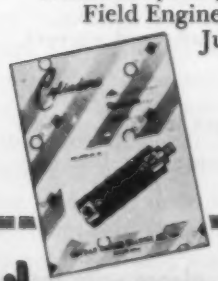


O-M cylinders (shown here installed on an automated speeder) are an integral part of "Gear-O-Mation" at Michigan Tool Company. In their automatic gear production line, O-M cylinders provide the muscle in the movement or holding of parts.

Important factors in Michigan Tool's choice of O-M cylinders for these machines were: *COMPACTNESS OF DESIGN* — their cleaner, more streamlined construction that allows installation in less space; *LESS MAINTENANCE* — easier to clean, inspect, remove, dis-assemble and service, if necessary, with no special equipment or skills needed. Knocks out downtime, keeps loading equipment in continuous operation.

O-M air and hydraulic cylinders are available in complete range of sizes (1½ to 8″ bores), with standard, 2 to 1 or oversize rods. All steel construction with bearing bronze. Completely interchangeable parts. Immediate delivery on many sizes.

Whatever your particular straight-line motion applications may be, an O-M Field Engineer will be happy to call and discuss them with you. Just mail coupon . . . no obligation, of course.



fit where others won't

mail coupon now!

for FREE catalog, showing all cylinders, mounts and mounting brackets.

ORTMAN-MILLER MACHINE COMPANY
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☐ Have representative call ☐ Send latest catalog

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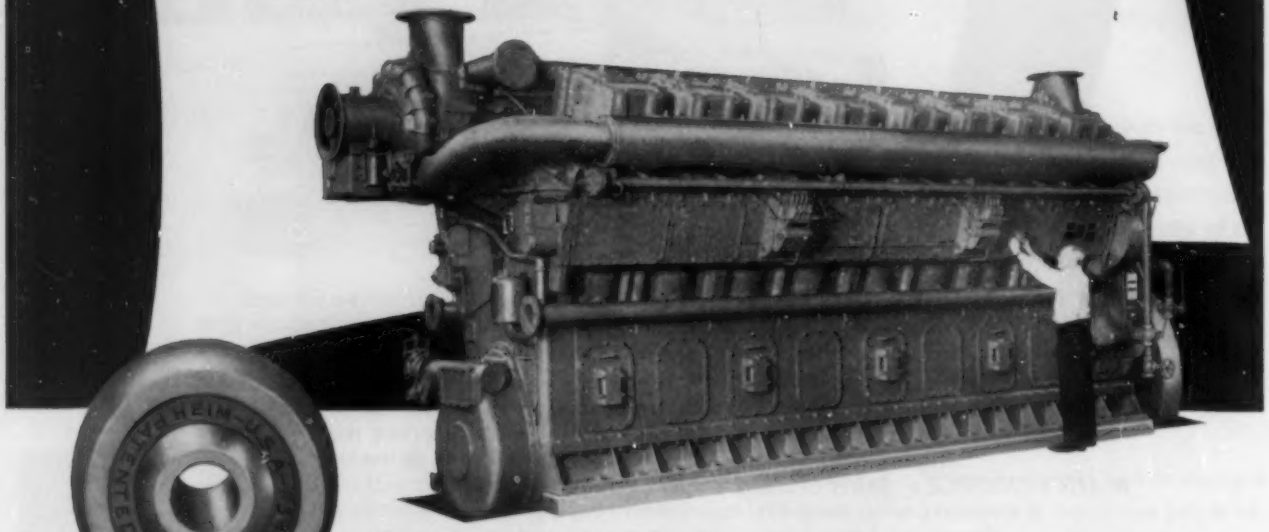
For Linkage Mechanisms . . . .

HEIM *Unibal* ROD ENDS

Ten Heim Unibal Rod Ends are used in linkage in this Gas-Diesel engine by Cooper-Bessemer Corp., Mt. Vernon, Ohio. This giant is rated 4080 h.p. at 360 RPM.

***You* may not make a product of such huge proportions, but wherever motion or power must be transmitted at odd or varying angles on equipment of *any* size, Heim Unibal Rod Ends are right at home.**



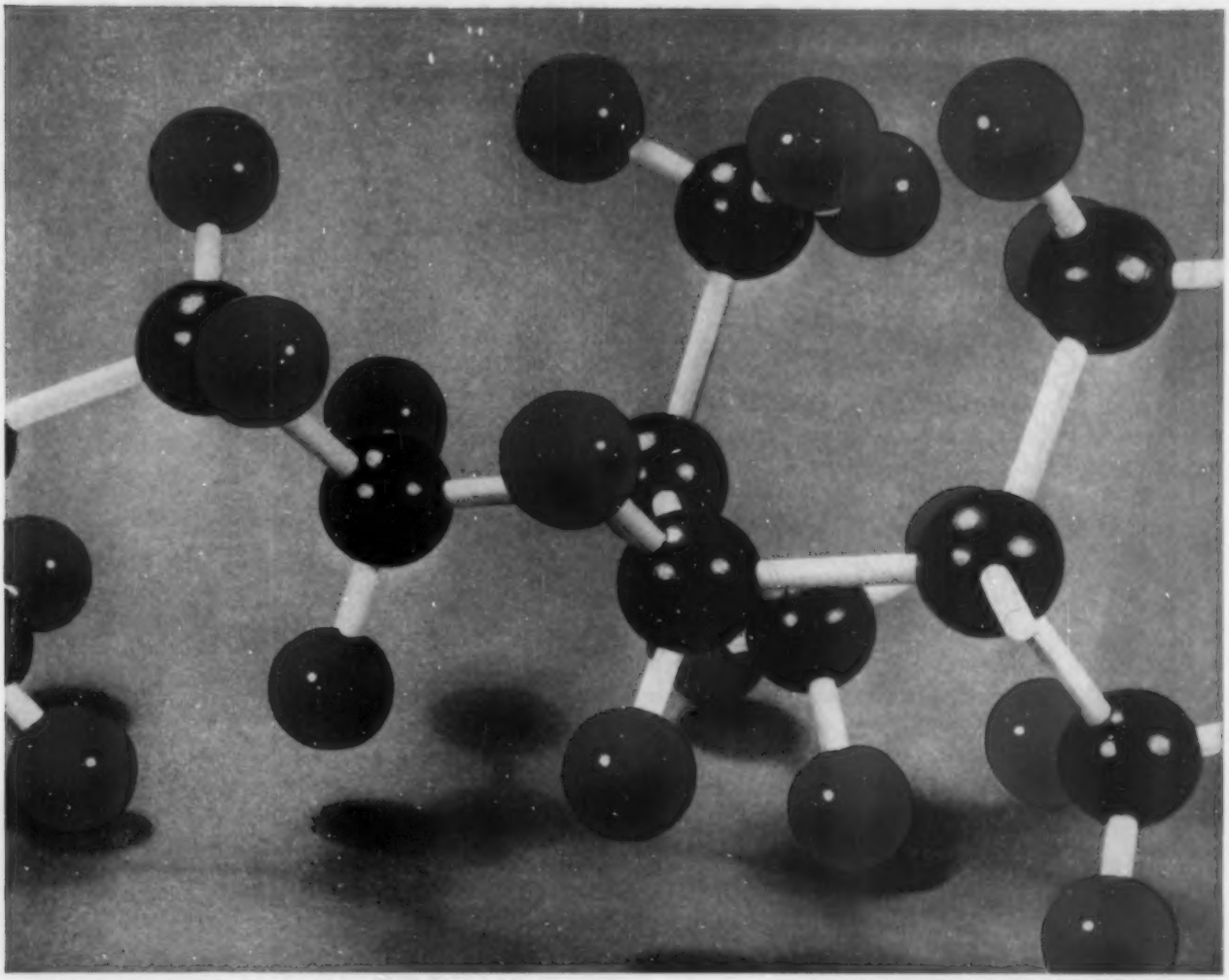
The Heim Unibal Rod End consists of a single ball of hardened steel, with a hole bored through its center, precision ground and lapped — supported by bronze bearing inserts — rotating in an outer member of carbon steel, or other specified material.

They carry maximum radial and axial thrust loads and correct misalignment in any direction.

Heim Rod Ends are made in a wide range of sizes in both standard and light series, and stocked across the country by bearing distributors.

Engineering data are complete in the new Heim catalog — please write for your copy.

THE HEIM COMPANY FAIRFIELD, CONNECTICUT



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Enjay Butyl—*greatest rubber value for electrical application*

Enjay Butyl, an amazingly versatile rubber, has opened a whole new field of electrical application. It has proven itself ideal in such varied uses as high voltage cable insulation, casing and insulation for indoor-outdoor transformers, and insulation for underground service cables. The reasons: its long life, low power factor and dielectric properties, stability to temperature change and resistance to heat and aging combined with its outstanding resistance to ozone and corona, superior low-temperature flexibility, and resistance to moisture absorption and abrasion.

● Check these three *outstanding* features of Enjay Butyl: *excellent electrical properties*, a *definite price advantage*, and *immediate availability*.

● Enjay Butyl may have a place in *your* operation. It can cut costs, increase the performance of your product. It will pay you to get all the information on this low-cost rubber. The complete laboratory facilities and skilled technical assistants of the Enjay Company are at your service. Contact them today.

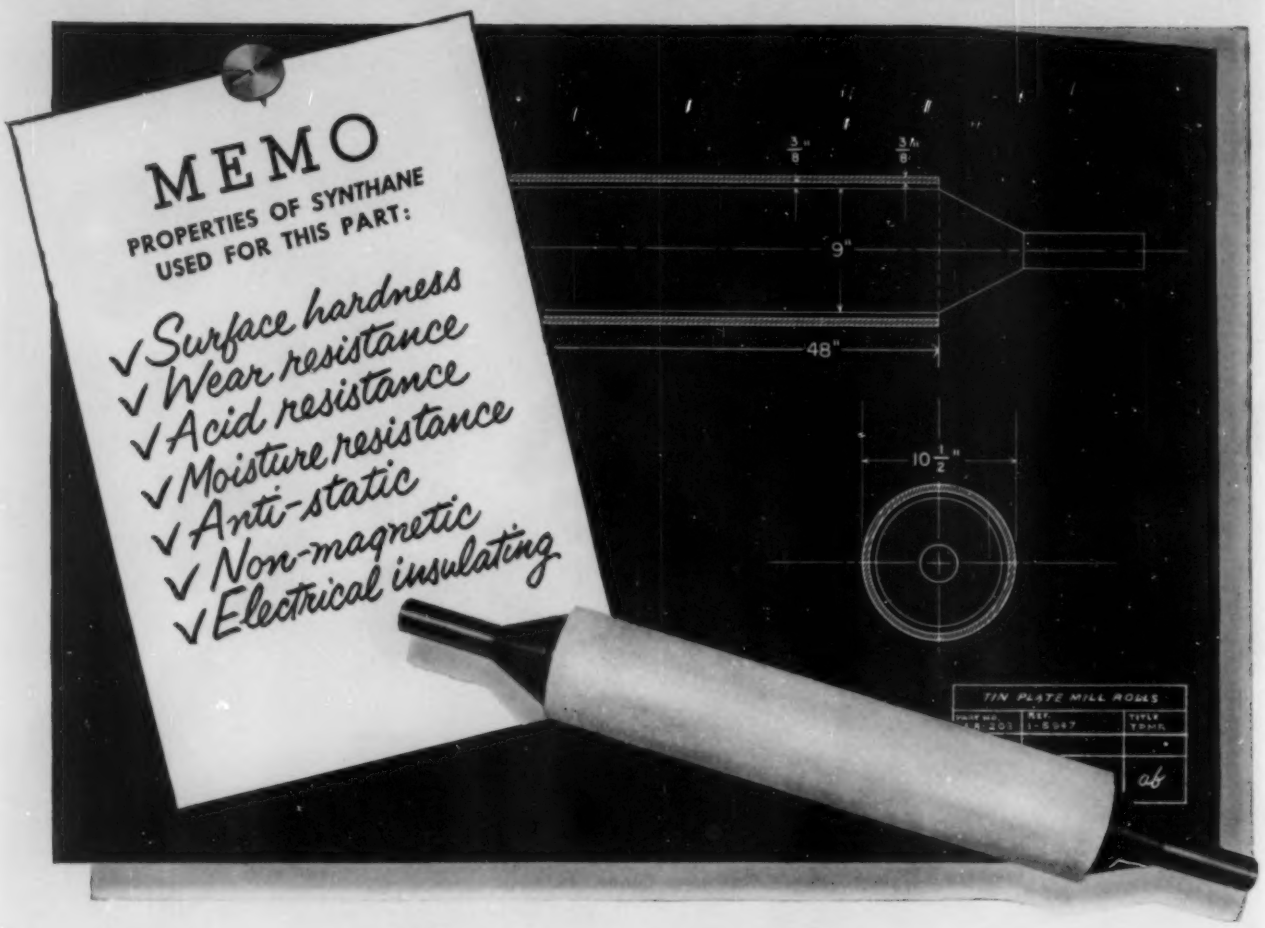
ENJAY BUTYL

Enjay Butyl is the super-durable rubber with outstanding resistance to aging • abrasion tear • chipping • cracking ozone and corona • chemicals gases • heat • cold • sunlight moisture.

ENJAY **ENJAY COMPANY INC., 15 West 51st Street, New York 19, N. Y.**
District Office: 11 South Portage Path, Akron 3, Ohio.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

YOU FURNISH THE PRINT, WE'LL FURNISH THE PART



TIN PLATE MILL ROLLS, COVERED WITH SYNTHANE LAMINATED PLASTICS, LAST 3 TO 5 TIMES LONGER, CUT DOWN TIME, IMPROVE PRODUCTION

The hundreds of rolls guiding steel plate through pickling, tin-plating and polishing operations at speeds up to 4100 feet per minute take a terrific beating from moisture, acid, sharp edges. Rubber-coated rolls sometimes last but a week. And tiny bits of abraded rubber prevent the deposition of the tin plate, mar the surface. Then Synthane laminated plastic covers were applied directly to the rolls.

What a difference! The hard Synthane surface does not become imbedded with foreign particles. Synthane is anti-static and non-magnetic, doesn't attract metal chips which could scratch the surface.

Synthane is also chemical-resistant; plating acids have little effect upon it, and being an electrical insulator, Synthane does not short the electroplating currents.

The net result is a 3 to 5 times longer life for Synthane-covered rolls, far less downtime; less maintenance and higher production rates. Look into Synthane's combination of properties for your product or application. Write for booklet of Synthane sheets, rods, tubes and fabricating service.

SYNTHANE CORPORATION, 4 River Road, Oaks, Pa.

Please send me more information about the combination of Synthane properties.

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Title_____

Company_____

Address_____

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SYNTHANE
LAMINATED PLASTICS

SYNTHANE CORPORATION • OAKS, PENNSYLVANIA

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AND ONLY ALEMITE HAS IT!
Alemite, originator of the lubrication fitting—acknowledged leader in the field—now brings you individually packaged lubrication fittings in handy "strips." You buy as many as you need. They stay clean, undamaged. No more dirty threads, no more clogged fittings! And best of all, no more figuring which fitting is which—no more fumbling around in a box of miscellaneous parts for the fitting you need.
Furthermore, when you order genuine Alemite fittings now — you know you get the real thing, because only Alemite has this advanced packaging. Just as only Alemite brings you the design advantages of the original, genuine, Alemite lubrication fitting!
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You can identify fittings at a glance! Saves time yet costs no more!
Hermetically sealed against moisture, dirt—keeps fittings clean!
FREE SAMPLE!
Write today for a free sample lubrication fitting in the new cellophane package. See for yourself how this new idea saves you time, trouble, money!
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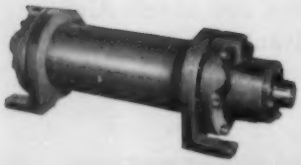
Call for Lindberg Red Cap!

A COMPLETE LINE OF AIR & HYDRAULIC CYLINDERS

Here is what to expect in a Lindberg RED CAP:

A rugged, dependable, long service cylinder that will do the job month in and month out. RED CAP identifies the famous line of Lindberg air and hydraulic cylinders, now made by Teer-Wickwire. These fine products are backed by expert engineering, made in a new plant equipped with latest type production machines, staffed by men schooled in precision work. New developments are in the works to extend the scope of our service to you. Expect big news from the Lindberg Air and Hydraulic Division of Teer-Wickwire!



AIR CYLINDERS

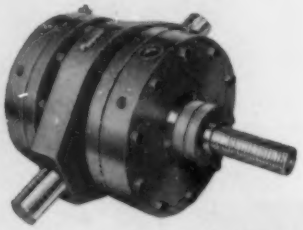
(low pressure)

For 150 p.s.i. maximum pressure. Bores 2" through 12" diameter. Heat treated aluminum pistons, cast iron cylinder caps and steel flanges. Retaining rings hold flanges to cylinder. Piston and rod packing, block "V" type.

HYDRAULIC CYLINDERS

(medium pressure)

For 1500 p.s.i. maximum pressure. Ten standard bore sizes, 2" through 8". Seven mounting styles. Standard rods or 2:1 differential rods available. Any length of stroke can be provided.



AIR CYLINDERS

(heavy-duty, mill-type)

For 250 p.s.i. maximum pressure. Thirteen bore sizes from 3" through 24". Six mountings. Constructed of heavy hot rolled steel plate, welded. Strongest possible power unit.

HYDRAULIC CYLINDERS

(heavy-duty)

For 3000 p.s.i. maximum pressure. Ten standard bore sizes from 2" through 8" diameter. Seven mounting styles. Standard rods or 2:1 differential rods available. Cast iron one-piece pistons; steel plate end flanges arc-welded to tube.

NEW SQUARE HEAD TYPE CYLINDERS

Now in the final stages of production testing—new square head cylinders that will set new standards of usefulness.

Compact, cleanly designed, space saving, dependable. Will be available soon in a complete range of sizes and mountings.

Write for FREE Engineering Booklets

LINDBERG AIR AND HYDRAULIC DIVISION
TEER-WICKWIRE & CO.
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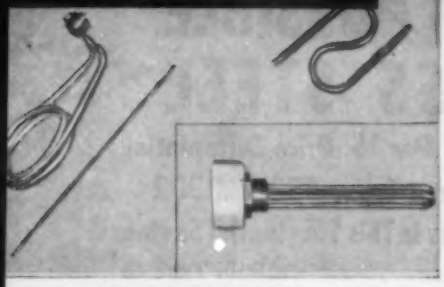
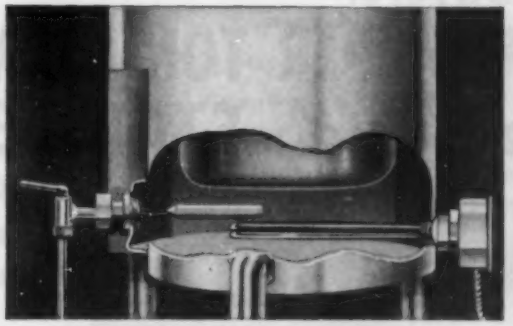
DESIGNING HEAT INTO YOUR PRODUCT?

"1001" G-E Calrod* Heaters Give You Design Freedom Plus Easy Installation

HEATING LIQUIDS



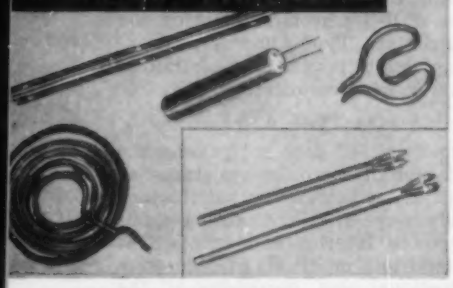


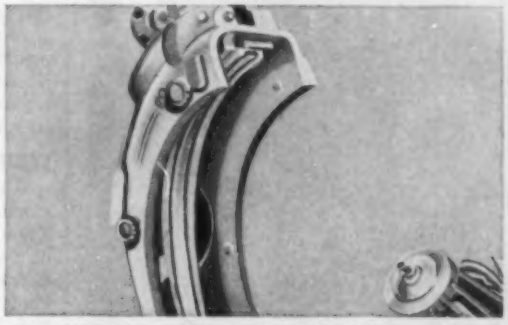
1 **GENERAL ELECTRIC** "screw-in" type heater is selected from wide variety of G-E immersion heaters by manufacturer of milk pasteurizers.

2 **EASILY INSTALLED** General Electric Calrod heater is inserted directly into side of pasteurizer. Immersion heaters provide maximum contact with water in jacket, minimizing heat loss.

3 **DEPENDABLE SERVICE** is assured by sealed terminals, high-grade resistance wire used in G-E immersion heaters. Milk spoilage is reduced.

HEATING SURFACES



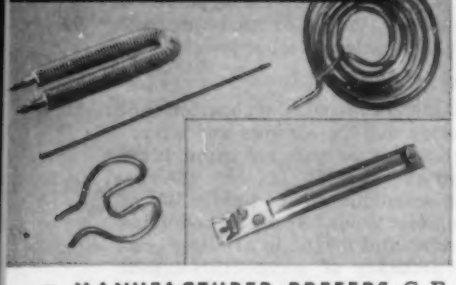


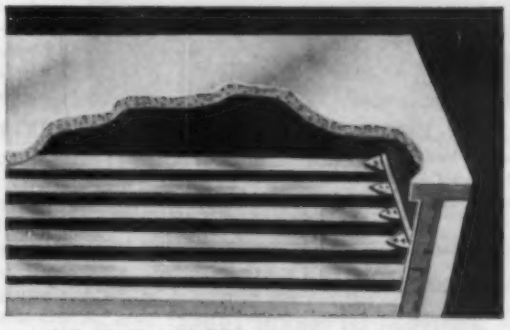
1 **FLEXIBLE BUT RUGGED** G-E tubular heaters are chosen by tire-retreader manufacturer after test. Other make heaters broke when formed.

2 **GENERAL ELECTRIC CALROD** tubular heaters bend easily to the curved shape of tire retreader. Heaters are inserted into grooves in heating plate to gain maximum heat transfer.

3 **EXACT HEAT** required for top-quality retreading of huge truck tires is achieved with high-efficiency General Electric Calrod heaters.

HEATING PROCESS AIR





1 **MANUFACTURER PREFERS** G-E "clamp-on" strip heaters for his high-temperature ovens. Versatile G-E tubular heaters could also be used.

*Registered trade-mark of General Electric Co.

2 **G-E STRIP HEATERS** are clamped to bottom of oven for maximum air movement. If a high degree of temperature uniformity is required heaters are clamped to top, bottom, and sides.

3 **FLEXIBLE PATTERN** and easy installation of G-E strip heaters reduces manufacturing costs—increases efficiency, improves saleability of ovens.

FREE

60-page Catalog of General Electric Calrod heaters and heating devices—describes full line. Also provides helpful application data. GEC-1005F.

Section C723-5, General Electric Company, Schenectady 5, N. Y.

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Company .....

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City ..... State .....

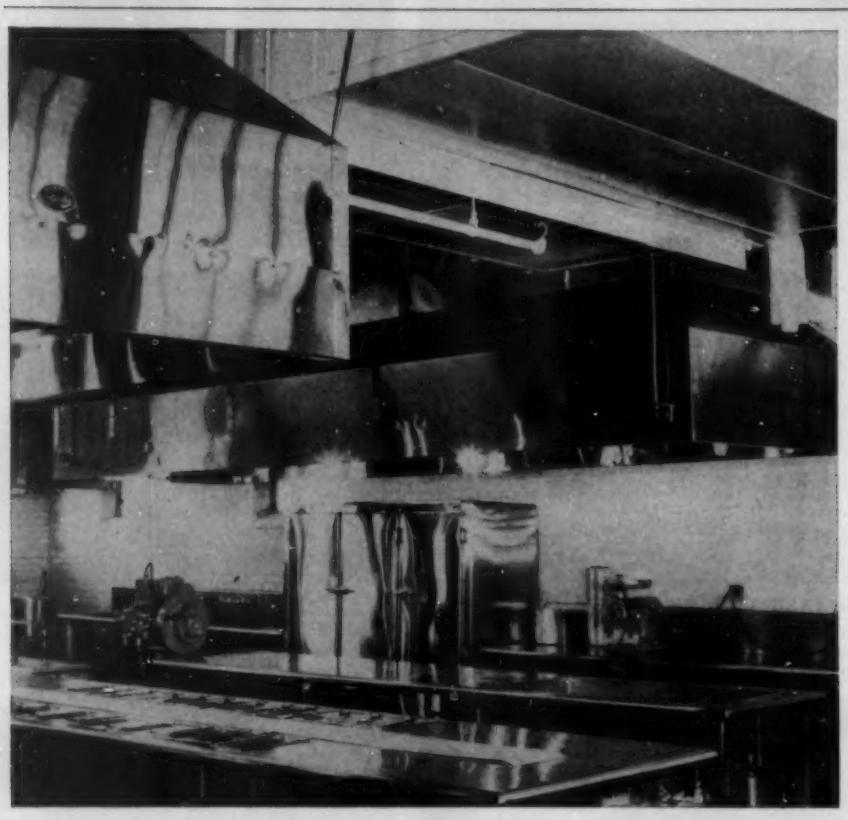
GENERAL ELECTRIC

Washington Steel News

PUBLISHED BY WASHINGTON STEEL CORPORATION, WASHINGTON, PA.

Stainless Steel Buyers:

SAVINGS OF $155 PER TON NOW POSSIBLE WITH *MicroRold*® STAINLESS STEEL



TYPICAL INSTALLATION OF MICROROLD TYPE 430—This Kitchen and Bakery Building of the South Carolina State Hospital, Columbia, S.C., is the largest institutional combined kitchen and bakery in the southeast. 18 gauge Type 430 stainless steel is used extensively in 17 exhaust and equipment hoods. They are designed for strength, appearance, and sanitation and were fabricated by Earl DeLay & Co. of Columbia, S. C.

7¾¢ Per Lb. Price Differential Between Types 430 and 302 Results in This Substantial Savings

By specifying MicroRold Type 430 stainless steel for suitable applications, stainless steel buyers can take advantage of the 7¾c per pound difference in base price between Type 430 and Type 302 stainless. A saving of $155 per ton merits consideration. Type 430 is a straight chromium-stainless with a nominal composition of 17% Chromium. During the Korean conflict, Type 430 was used extensively, due to government restriction on nickel-bearing stainless.

WIDE USE FOR TYPE 430

While Type 430 does not possess the same degree of corrosion resistance as Type 302, it has proven very satisfactory in a wide range of mild corrosion applications, both interior and exterior. It lends itself to a multitude of decorative and functional uses, combining all the advantages and qualities of stainless steel — beauty, strength, corrosion resistance, long life, workability and ease of maintenance. Considering the price advantage, with no sacrifice in quality when applied properly, stainless steel buyers will find MicroRold Type 430 a worthwhile material for an impressive number of stainless steel applications.

EXTRA SAVINGS

Washington Steel Corporation not only points out the savings and advantages that may be acquired through the selection of Type 430, but also the significant economies in its production of all stainless types. Special production equipment and methods produce controlled accuracy of gauge throughout length and width of the entire sheet; thus, MicroRold may be specified by decimal thickness (with tolerances as low as 3% average) instead of gauge number. By specifying MicroRold sheet rolled to the light side of the gauge range, purchase costs are reduced by the savings in weight. While this saving may not be apparent in every single sheet, weights will average less than the theoretical when bought over a period of time. **Your steel distributor can give you full information on how you can get the most out of your stainless steel dollar. He will gladly tell you the MICROROLD STORY.**

Type 430 Satisfactory For Mild Corrosion Applications

This straight chromium-stainless grade possesses desirable properties that recommend it for a diversity of applications under general atmospheric conditions. It is non-hardenable by heat treatment and is only mildly hardenable by cold working. It has moderate ductility, good forming and bending characteristics and can be drawn to a moderate degree.

Brazing and soldering are easily accomplished, and except where resistance to high stresses is a major factor, it welds satisfactorily by the usual methods. Before fabricating MicroRold Type 430, it is advisable to consult our mill or distributor to make certain that it may be used successfully in your particular application.

Type 430 Good Insurance Against Shortage Of Nickel Types

Any restriction or curtailment of nickel-bearing stainless (as during the Korean Engagement) could have serious effect upon stainless steel fabricators. By making use of Type 430 wherever feasible, stainless fabricators can insure themselves against any unforeseen developments in the supply of stainless steel.

Perspectives

IN DESIGN AND DEVELOPMENT

THE URGE TO GROW

There are a number of reasons why one company seeks to acquire the assets, stock, or control of another, and it all adds up to a merger rate which is three times that of 1949, and at the postwar peak of 1946-1947. However, it is still far below the pre-depression rate of the late 1920's. In a recent survey, the Federal Trade Commission found that there have been 1,773 mergers and acquisitions in the mining and manufacturing fields alone from 1948 to 1954. Of this number, nearly two-thirds of the acquiring companies had assets of $10-million or more. By contrast, companies with assets of less than $1-million accounted for less than eight per cent of the total.

The greatest number of acquisitions were made by companies classified in the nonelectrical machinery industry, and the food and related industries, in that order. The acquiring firms in these two industries were responsible for 492 mergers and acquisitions. The next most active industries were the chemical (168 mergers), and fabricated metals (161). The specific company leaders with the number of acquisitions are: Foremost Daries (48); Borden Co. (17); Olin-Mathieson Chemical Corp. (16); Food Machinery & Chemical Corp. (14); H. K. Porter Co., Inc. (13); Burlington Mills Corp. (12); American Marietta Co. (12); American Machine & Foundry Co. (11); and Ekco Products Co. (10).

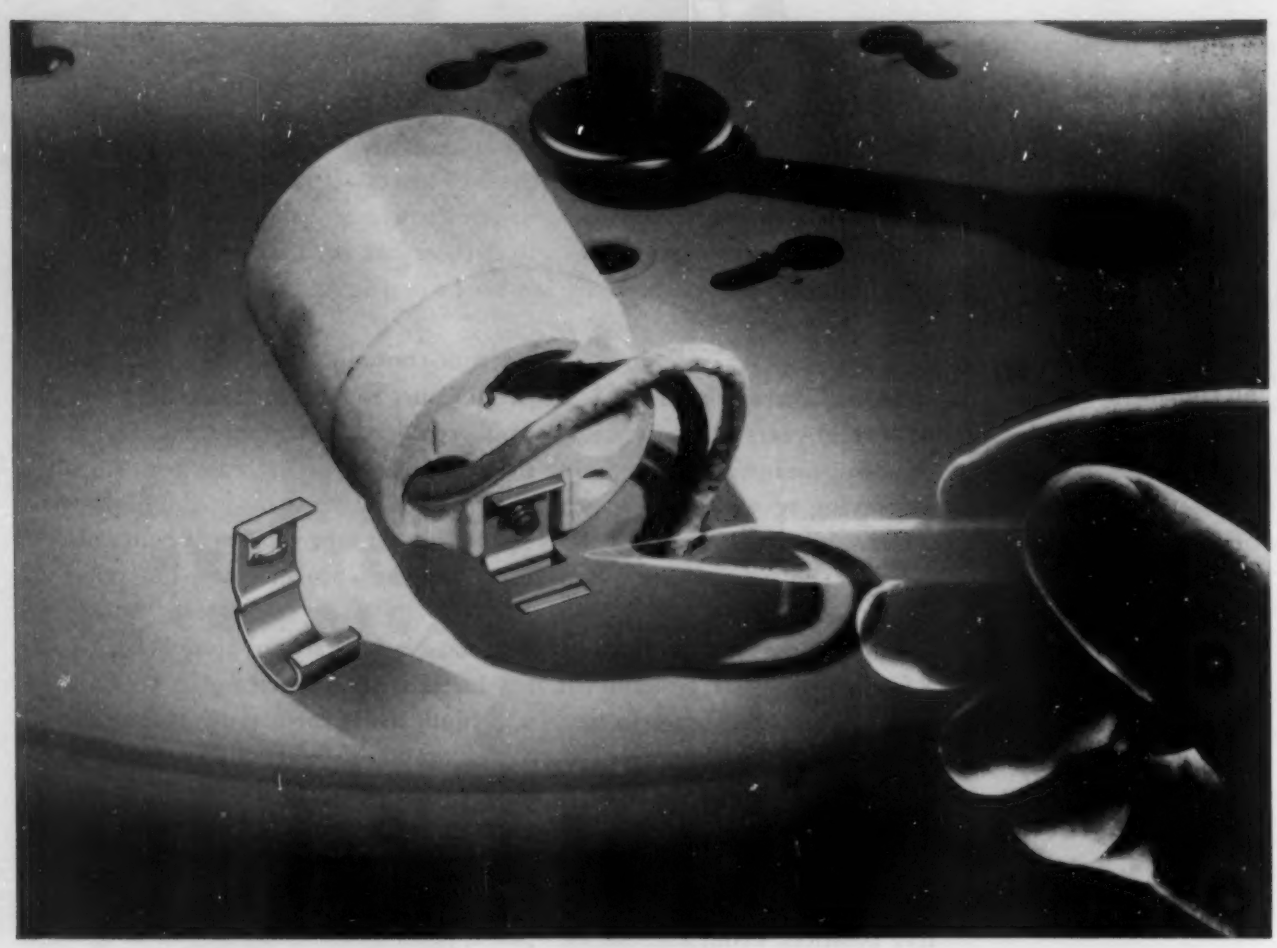
WHY MERGE?

While there are almost as many different reasons for merging as there are mergers, the FTC found that these were the main ones: To add to total capacity, 40 per cent; Add to capacity in a specific area, 10 per cent; Diversification of products, 25 per cent; Gaining a source of supply, 12.5 per cent; To move into the consumer market, 10 per cent. Often, more than one of these reasons is present in a company's decision to merge. But there are other factors like: the inability of a small company to get adequate financing for expansion and modernization (beat the high cost of construction); surplus cash of the acquiring firm; aging owners who want to retire or adjust estates; and the tax savings under provisions of the internal revenue act that grants more favorable rates on capital gains, tax free exchanges of stock, and tax advantages by carrying forward past operating losses as credits against future earnings.

GOVERNMENT CAN STEP IN

One big difference between the mergers of pre-1950 and those since then is that the government now has the power to take both parties to a merger into court—before and after the merger takes place. The rash of mergers in 1946-1947 prompted federal action, with the result that the Clayton Antitrust Act was tightened up in 1950. Prior to this, the government could actually do little to prevent or break-up some mergers, because the law did not apply if one company bought the assets of another. With the 1950

(Continued on page 125)



Engineered by Tinnerman . . .

THIS SPEED NUT® FASTENS WITH ONE MOTION, STAYS TIGHT FOR KEEPS . . . and saves money!

This SPEED NUT developed specially for ceiling lights produced by the Imperial Lighting Products Company, Latrobe, Pennsylvania, gained almost unbelievable savings of 80% in assembly time!

Once fastened to the socket assembly, it snaps into position quickly and easily by hand. No special tools or skills required. And this one-piece, spring-steel SPEED NUT does the job better than the three parts it replaces—a nut, screw and special tapped bracket. Additional savings are possible because there are fewer parts to purchase, stock and handle.

This is a typical example of SPEED NUTS engineered for special fastening applications. Tinnerman develops an average of 4 new SPEED NUTS every day for products of every description. And there are more than 8,000 existing variations to choose from.

A Tinnerman Fastening Analysis Survey can quickly tell you where SPEED NUT brand fasteners belong on your assembly line. Call in your Tinnerman representative soon for full information and write for our Fastening Analysis Service Bulletin No. 336.

TINNERMAN PRODUCTS, INC. • Box 6688, Dept. 12, Cleveland 1, Ohio

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN **Speed Nuts®**

FASTEST THING IN FASTENINGS®

Germany is Marching Again

It is not unusual for an American company to manufacture a million or more washing machines, radio sets, automobiles or other products. That is why only in the United States of America is it economically possible to spend millions on tooling in order to produce with a minimum expenditure of human effort.

Conversely, because the production lots in Europe are relatively small, rarely running more than a few hundred thousand, it is not possible to spend much money on special tools, jigs and fixtures. Hence the relatively limited use of automatic production machinery in those countries; which in turn is a large contributing factor to the low labor rates.

When producing on automatic machinery, little or nothing can be saved by going to the extremes in simplifying the design of the part. A few unnecessary counter bores, tapped holes or finished bosses can be produced on transfer machines at practically no additional cost. The product designer merely casts upon the tool designer the burden to make the part economically, requiring him to design slightly more complicated tools and jigs. Perhaps this explains why in so many instances the design of the pieces is not as plain and simple as it could be.

A study of designs developed by German engineers often shows a great deal more thought, ingenuity and analysis with reference to the manufacturing costs involved. Their designs must be producible at lowest cost on simple general purpose machine tools and without requiring expensive jigs, tools, or setup time. The limited number of units to be produced does not warrant it. Low cost must be achieved by making it inherent in the design.

Of course, production methods and machinery must always contribute their share toward cost reduction. To this end the Germans have designed many general purpose production machines that possess features that contribute to highest production rates and maximum flexibility. Also, the Germans have developed and use new production processes that make possible low cost production with a relatively low tooling charge. The precision casting of metals by the Kroning shell molding process is one example. Precision forging of gears that require no machining or grinding of the teeth is another example. German progress in powder metallurgy falls in the same category. But perhaps the most striking of all is the ingenuity of the German engineers in design of weldments, tubular designs and other ingenious welded constructions.

In the months to come we will present to our readers many articles and a great deal of information and data on design techniques for cost reduction as practiced by German engineers.

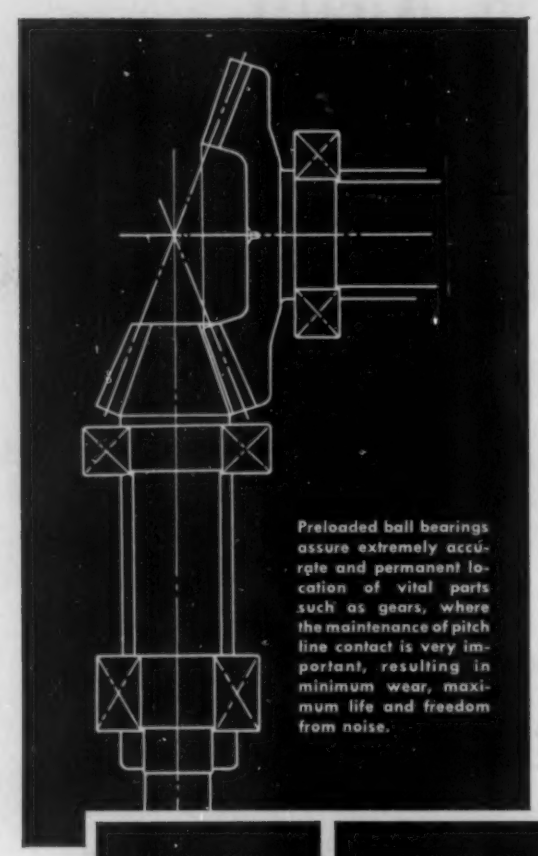
Germany is marching again but this time it is not a goose-step but a parade of scientific and technological progress.

George F. Bodenhoff

FACTS

about

NEW DEPARTURE
BALL BEARINGS



Preloaded ball bearings assure extremely accurate and permanent location of vital parts such as gears, where the maintenance of pitch line contact is very important, resulting in minimum wear, maximum life and freedom from noise.

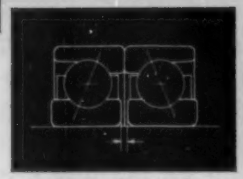
How Preloading Pays Off in Accuracy!

New Departure pioneered preloading to give you a new measure of machine accuracy! This accuracy, due to increased bearing rigidity, pays off in high-precision machines, where the slightest deflection caused by work loads on moving parts can be crucial to the ultimate performance of the machine.

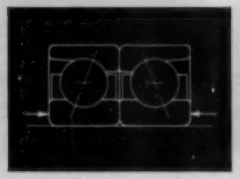
By placing a predetermined internal load on the bearing, either at the time of manufacture or at installation, deflection due to the work load is greatly reduced. This means not only that machine accuracy is greatly improved, but that the ball bearing characteristics of low torque operation and long life are fully retained.

If you are seeking a solution to your bearing problem, call on New Departure for the answer. You will benefit from more than 50 years' experience in bearing design, testing and manufacture.

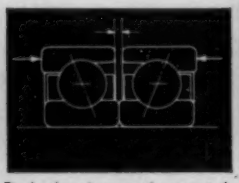
Send for Booklet BA-2 on ball bearing application



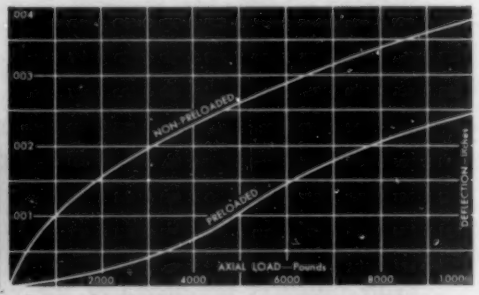
Preload is predetermined, then accurately obtained by grinding Duplex bearing faces so that an exact and fixed compression will take place when mounted.



A Duplex bearing, in effect, becomes a preloaded double-row bearing capable of holding parts within close limits, both radially and axially.



Duplex bearings may be mounted in several different ways to suit load conditions. In each case, extra rigidity of shaft centering is obtained by preloading.

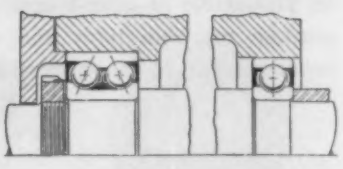


The benefits of preloading can be seen from this deflection curve. The double-row ball bearing referred to here is the most rigid type of unit bearing made to resist loads from any direction.

Typical Application of New Departure Preloaded Ball Bearings

The extreme resistance to deflection and the freedom from wear offered by the New Departure double-row bearing make it a favorite wherever exact location of parts under combined loads must be assured not only initially, but throughout long usage.

In this typical application the double row, solidly supported against suitable housing and shaft shoulders and with a "floated" single row at the other end, provides one of the best general-duty mountings where considerable thrust is present.



NEW DEPARTURE • - DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

PRODUCT DEVELOPMENT CONFERENCE

On April 4, 1955 department heads of the Yale Materials Handling Division of the Yale & Towne Manufacturing Company gathered to discuss their development program of the G52 line of industrial trucks.

Excerpts from this three-hour long recorded session are presented here, giving the views and experiences of these men on the origins of products, product appearance, communication within the organization, organization environment and some specific features of this new line of fork lift trucks.

OSWALD CARLISS, *Director of Engineering*

GEORGE QUAYLE,, *Assistant Director of Engineering*

FRANK MINNELLI, *Manager of Market Research*

RICHARD BRACKIN, *Chief Engineer, Gas Trucks*

BRUNO MOSKI, *Director of Industrial Engineering*

C. EUGENE MOORE, *Works Manager*

JAMES CONKLIN, *General Sales Manager*

PAUL METZGER, *Assistant to the Vice President in Charge of Production Control and Purchasing*

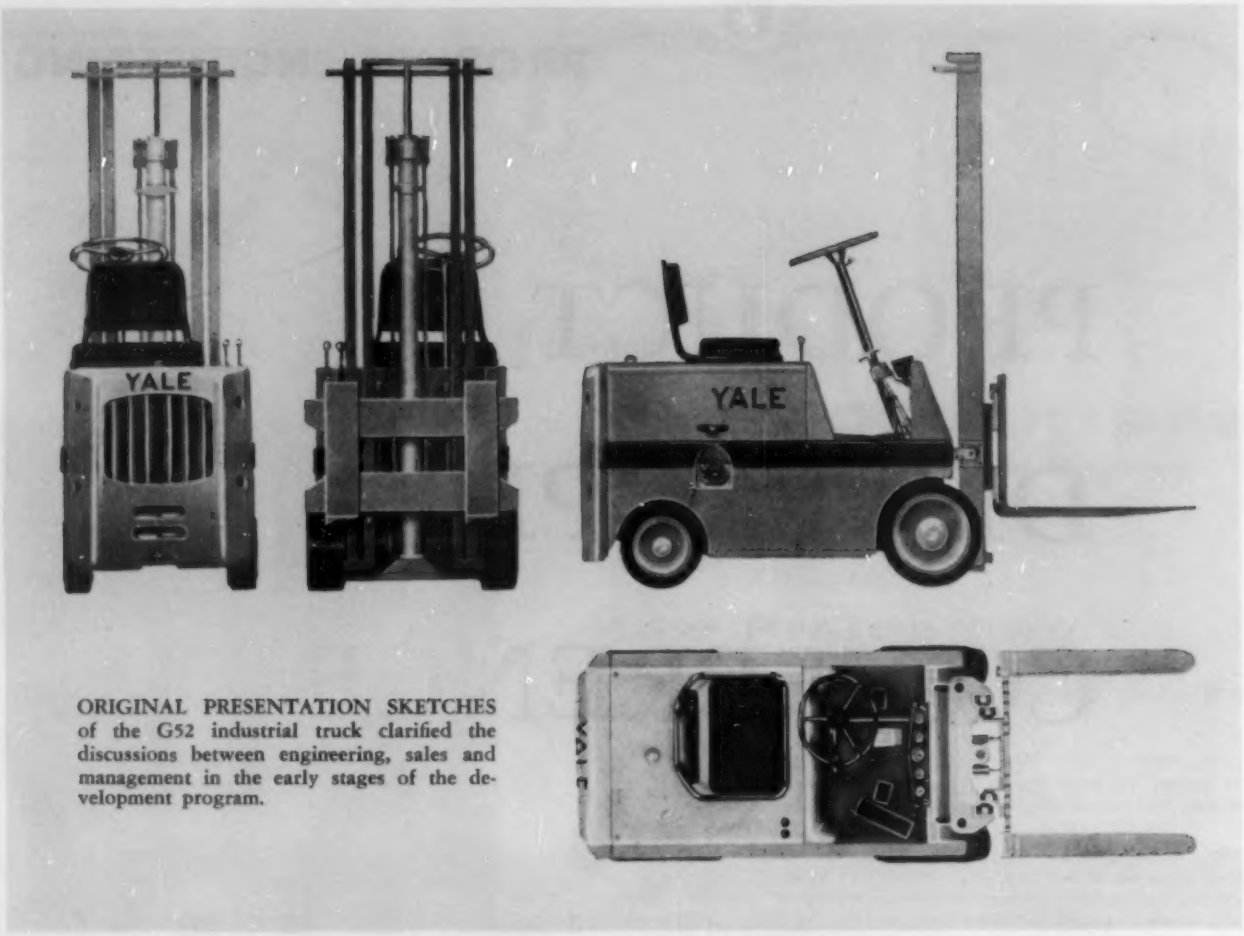
Why Make a Product Change?

Carliss: The basic reason for making a product change appears whenever we see an opportunity to advance our share of the market.

Minnelli: Market research circulates a monthly report among top management, sales, and engineering. These reports are summarized every quarter in our executive marketing summary and supplemented by trend data going back four or five years.

This running examination of the competitive situation plus reports from our field representatives form the basis of our decisions about product development.

Conklin: Generally the sales department says, "If you can give us a truck of roughly these dimensions and in this capacity range, in which we could have these advantages, we could sell X number of these machines per year at such a price." Engineering cannot do everything we ask



ORIGINAL PRESENTATION SKETCHES of the G52 industrial truck clarified the discussions between engineering, sales and management in the early stages of the development program.

but they can do some things we didn't think possible.

Carliss: Often there are several approaches to a problem. Industrial engineering evaluates them and chooses the most economical one. After all, engineering is about eighty per cent economics; twenty per cent is stress, design and ingenuity.

Moore: Coincidental with market research, we had been improving our manufacturing facilities from a capacity standpoint. We were able to improve appearance, quality, give untold reduction in labor time, and better uniformity of pieces with the new equipment. At a preliminary drawing review, the engineering design concept was adapted to the manufacturing facilities and tooling.

Brackin: To design for the more economical quantity production we take basic building blocks and use them over a broad truck capacity range. That is where we differ from industries in which the specific design factor is primary. Individual blocks are combined to make a truck, but the elements may be used on a variety of products.

What Were Some of the Specific Changes in the G52?

Brackin: We are in a very rapidly changing market. No one design survives too long. Our previous model was large in an industry in which dimensions are critical. Maneuverability in small aisles and in box cars is a primary factor. Hoist speeds and drive speeds had to keep pace with the market or better it. Gear shift handles are awkward on the floor of the truck so we put them on the steering column in automotive fashion. We increased speed of operation by improving the forward to reverse gear shifting operation.

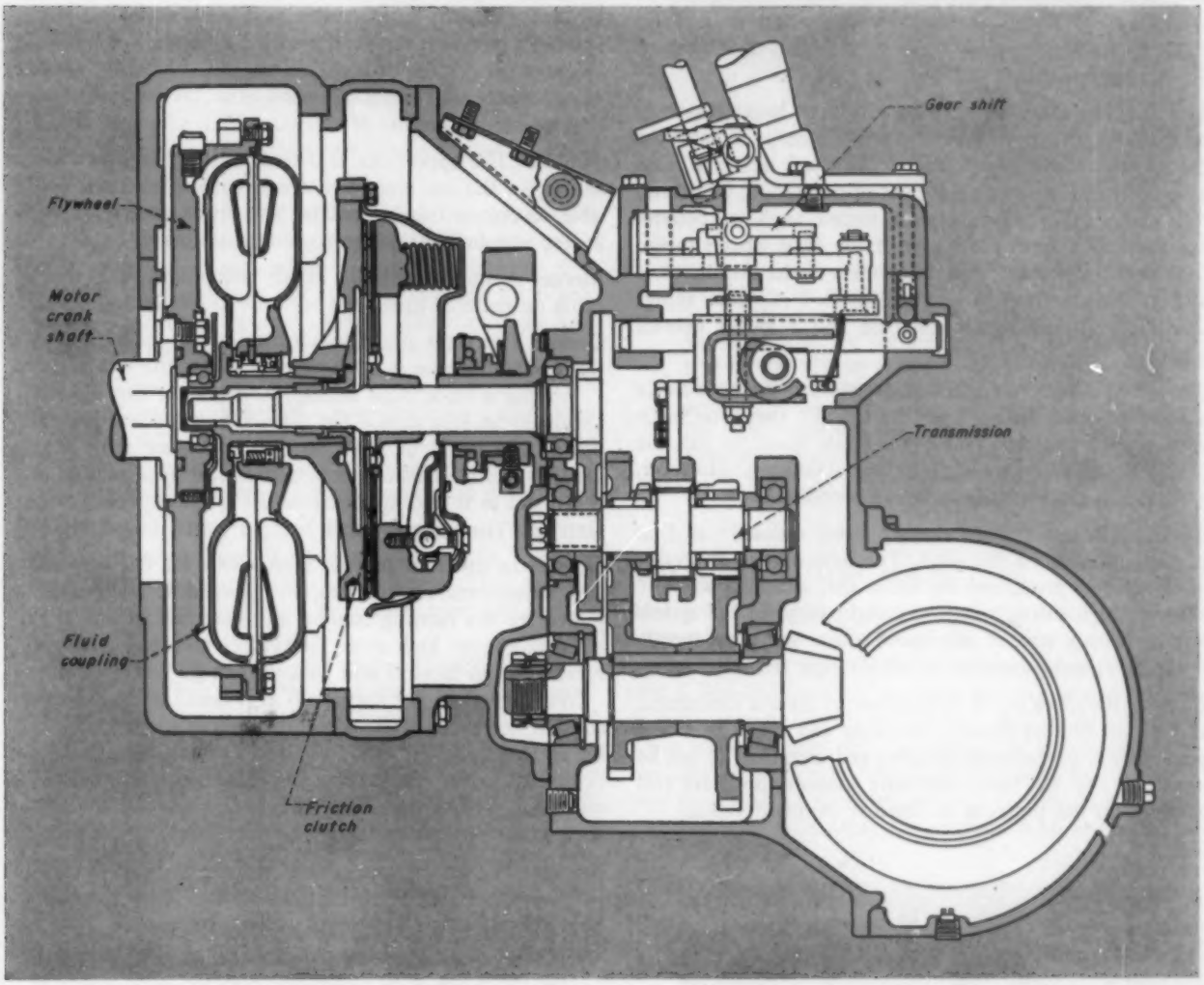
We tried to better suit the truck to the operator and to the operation. A new fluid coupling made the truck more efficient to operate as well as improved the service life of the clutch. Pneumatic tires as well as solid tires were required in order to fill an area of the market we had never touched before.

The reasons for the fluid coupling on the truck are not necessarily unique with the G52. Before the introduction of either the fluid coupling or the automatic transmission clutch life was often very short. The fluid coupling increased the life span of the clutch by a large ratio.

Carliss: We were pioneers in the industry in putting the fluid coupling into fork trucks. The coupling design for our G52 model came to our attention through our research group who found we could use half of a double coupling made by Twin Disc which would give us a characteristic that came close to the engine requirements.

In order to meet dimensional requirements we machined

INTRODUCTION of the fluid coupling between flywheel and friction clutch reduced wear on friction clutch and made truck easier to operate. Fluid coupling is recessed into fly wheel to minimize over-all length of truck.



a cavity into the flywheel for the coupling. We couldn't research, develop, engineer, and produce a fluid coupling ourselves without having to sell it for more than the entire truck. We took the best the supplier had to offer and adapted it to our needs.

Brackin: The mast had to meet new requirements in new fields. The cotton industry uses an attachment which applies very severe side loading. Hoses for hydraulic attachments had to be placed inside the channels to protect them from damage. Visibility and driver location, foot room, driver comfort, all had to receive serious consideration.

Quayle: We are endeavoring as an industry to make the carriage interchangeable with all trucks so that an attachment which was sold on the Yale truck can be transferred to a competitive truck.

The industry has arrived at standard dimensions; the height of the carriage, the thickness of the plate, the angles of machining, and we incorporated them into the G52. We are leading the industry in this standardization procedure. Everybody else will follow as they come along with new models.

Carliss: Fork carriage standardization afforded us the best opportunity to reduce the dimension from the face of the fork to the center of the front wheel. Other designs in the past, including our own, had fork hangers which added to this dimension or used some thicker than standard fork carriage.

The counterweight requirements determine the dimension from the back wheel to the rear of the truck. We worked a 5-in. sq. billet into the design of the chassis which enabled us to cut down the amount of cast iron counterweight and therefore reduced this dimension. The muffler was fitted into the counterweight, saving a little space, and by these changes, plus changes in the engine suggested to the vendor, the truck was reduced to a competitive length.

Brackin: In the design of a truck for both pneumatic and

solid tires, there is the inescapable fact that pneumatic tires are usually 50 per cent larger than the equivalent solid tire. Two different frames are required and the trick is to keep most elements of the two frames alike. Cowls and cross plates are identical, but wheel wells must be engineered specifically to either the pneumatic or the solid tired job. Interchangeability can be maintained on perhaps 50 per cent of the parts, keeping production up.

Carliss: The pneumatic tired truck is larger than its solid tired counterpart. A short wheel base pneumatic tire truck has the tendency to behave like a jack rabbit. It hops along. To take the jack rabbit out of the design, we extend the wheel base. That's almost forced anyhow, because the dimension from the center of the drive wheels to the base of the fork increases as the radius of the tire increases and more counterweight length is needed. All these things contribute to a longer wheel base and a longer over-all length.

Quayle: We went to higher oil pressures in order to make a more compact lifting unit; we can lift the same loads with smaller cylinders and components when we run the pressures up from about 1,200 to 2,000 psi. However, valving and clearances become more critical.

Carliss: The relief valve doesn't open suddenly at that magical number on the valve. The hysteresis in any valve of that sort is great, and we found that although we were enjoying high lifting speed, any slight surge in the system would sharply reduce the speed since we were merely pumping great quantities of oil through the relief valve.

Brackin: Relief valves at these pressures have a differential as high as 500 psi between cracking and total open and possibly 300 psi between cracking and reseating. It can be improved and has been, but valve manufacturers are still working on the problem to improve standard valves.

On Appearance

Carliss: Over the years the previous model had collected a lot of holes for bolting attachments as the individual customer requirements were integrated into the engineering program. The front end of that truck looked as if it had been caught at close range with a shotgun. We wanted to clean that up. It had to be a rugged, clean-lined piece of equipment that could be produced in the cost structure that we could afford.

Conklin: The appearance is determined by the functional activity of the machine. You round corners wherever possible to reduce turning radius. You strive always for the lowest seat height and best operator visibility.

Moore: A smooth exterior avoids protrusions that could catch on material in storage adjacent to the load.

Carliss: The truck must be narrower at the back than at the front otherwise it is possible to corner the truck.

We put a black band around the truck for two reasons. Originally an area around the side of the truck was pressed out of the metal in order to give a wearing strip. The strip was painted black because it looked as attractive in the metal as it had appeared in the original presentation sketches. The general effect being a lower, longer truck.

Quayle: In order to provide more room for the operator and naturalness of function, the gear shift handle was placed on the steering column and designed so that it is lifted to go into high speed, lowered to go into low speed, forward to go forward and backward to go reverse.

We wanted to get the whole floor board opened up in contour; toe room in the corner, heel room where it should be, so that operators with large feet could be comfortable in the truck. We pushed the accelerator pedal way over to one side so that operators with long shins would have their knees out where they were clear of the mechanism.

Brackin: We have paper models of average and abnormal people and we seat them on the drawings to get the basic proportions which are then proven by people in the mock-ups.

We made the seat adjustable and put the hydraulic controls beside the seat. Too many levers in a row caused

Some attachments available for incorporation

FORK ROTATOR

HOLD DOWN

GRIPPER

CLAMP ROTATOR

confusion of operations. Having the gear shift lever up at the wheel and the hydraulic levers down beside him permitted maximum driver comfort with best control accessibility.

Moski: We made an exhaustive study, with motion pictures, of the conventional truck, and detailed time data has been published reflecting the speed of operating these trucks. That information was given careful consideration in the execution of the design. Among other things, it pointed out that if a man wants to alternate standing and sitting it would substantially slow down the operation of the truck.

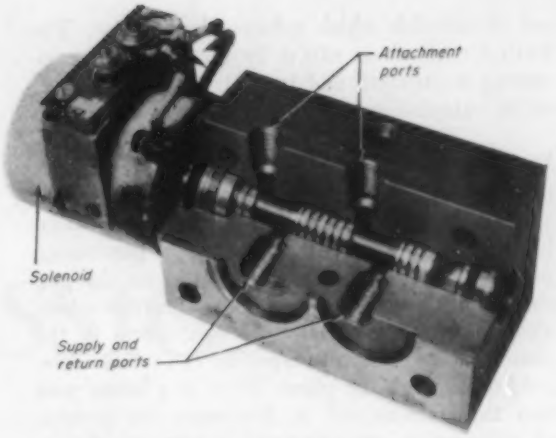
Carliss: The study indicated the need for the straight line forward and reverse shifting of the valve controls; the natural movement of the operator's arm is to drop right where he will have the hydraulic controls for tilting, hoisting, and auxiliary attachments. These changes have proven very popular with our customers.

Quayle: There are two hydraulic control levers, one for lifting and one for tilting. We have space for a third lever to operate attachments, with push buttons that give a selection of multiple functions. The objective here is to provide a simpler means of control keeping all the controls centralized in one area.

Carliss: Research is out ahead of us all the time. They are developing ideas rather than components. They foresaw the need for a selector valve in another operation and we incorporated it into our design.

Customers were asking for equipment with more than one hydraulic function. We had built such equipment before—side shifting, rotating and clamping are three of the basic auxiliary motions—with six hoses. By putting the hoses inside the channel and adding the selector valve we needed only one pair of hoses, one wire, and three push buttons on the control handle.

The truck is not as comfortable as sitting in an easy chair watching TV, because these trucks have no springs. We depend on the seat cushion and the wheels. We did find that you could make the seat too soft, and the riding on an air cushion gives a sense of instability to the driver. A harder cushion providing firm support was better.



FLOW FROM PUMP is regulated or reversed by a lever operated valve and supplied to the pictured selector valve. A button on the lever controls the solenoid position moving the spool to the left (as shown) when depressed and connecting the oil circuit to the attachment actuator. When the button is released the spool moves to the right connecting the oil supply to a second pair of attachment ports at the rear of the selector valve. These selector valves may be stacked to provide for additional attachments individually button controlled.

On Communication

Metzger: Communications in product development are tremendously important. To help in this area we have created what we call a Birth Certificate. The Birth Certificate is initiated for every new part and engineering change. It lists necessary details for the tool division to determine when tooling effort must be completed. It tells industrial engineering what they have to do in connection with the new part, such as operation schedules, costs, and the like, and it informs purchasing and production on the balancing

SCOOP

on standard lift truck

LARGE GRIPPER

PUSH-PULL LOADER

out of materials which reduces obsolescence. The Birth Certificate is edited by the industrial engineering department and from it we estimate dates of the completion of all phases of our operation.

Moski: We have a procedure which is at variance from the normal production control function. We assign a methods engineer who provides the liaison between engineering, manufacturing, purchasing, production, and experimental. He issues the purchase requisitions. He prepares the operation schedules which are used as production orders to the plant, and he personally expedites the various components through the plant. He is in a better position than anyone else to determine the position of engineering, manufacturing, tooling, and purchasing each week, and he prepares a detailed weekly report which goes to top management and the various department heads. On the basis of that weekly snapshot, he attempts to forecast the date when the pilot model will be complete.

This continues to the point where engineering is satisfied with the pilot model and the executive schedule is established for large scale manufacture.

Carliss: We try to build a small lot off the tooling first because changes in the tooling are to be expected. We run that limited lot down our production lines and the experimental people act as supervisors or instructors.

There is good labor acceptance of this technique. They don't object when men from the engineering department in overalls are down on the lines, guiding the assembly of these first units.

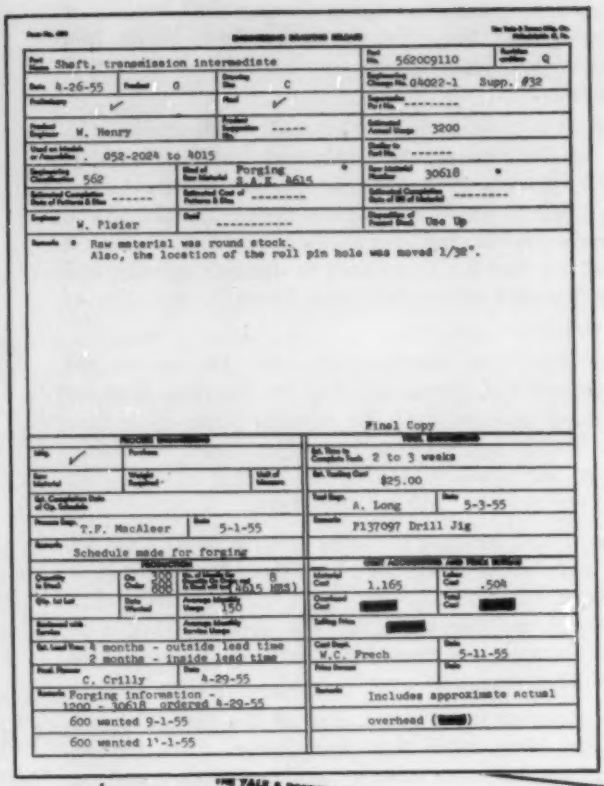
Organization Environment

Carliss: Encouraging creativeness and cooperation in an organization of this kind is tremendously important. I am convinced that a sense of accomplishment is a vital part of a man's well being. It is not necessarily measured in terms of money. Gene Moore calls it psychic income. But there is no accomplishment without cooperation.

Brackin: Modern manufacturing has become so complex that no individual can comprehend and properly evaluate all of the problems. There must be cooperation between the specialist groups in order to make a profit.

Moore: Mutual respect and the ability to argue yet still maintain that respect is essential. It's not the kind of cooperation which is always submission.

Carliss: Therefore, it is not developed by administrative edict. What Gene Moore has said is equally true about an atmosphere where creativeness flourishes. The great creative periods are not periods of luxury or lassitude, they are periods of stress, strain, upset and so there must be an aggregation of individuals who assent to working together; not a group driven by some over-intelligence.



Shaft, transmission intermediate — Part No. 562009110 — Date 4-26-55 — Product G — Drawing No. C — Customer Part No. G4022-1 Supp. #32 — Preliminary ✓ — Final ✓ — Product Engineer W. Henry — Product Inspection No. ----- — Estimated Annual Usage 3200 — Used on Models or Assemblies 052-2024 to 4015 — Change to Part No. ------- — Engineering Classification 562 — Kind of Raw Material Forging S.A.E. 8615 * — Raw Material Number 30618 * — Estimated Completion Date of Pattern & Dies ------ — Estimated Cost of Pattern & Dies --------- — Estimated Completion Date of 1st of Machined ---------- — Engineer W. Plaier — Cost ---------- — Disposition of Present Stock Use Up

Remarks * Raw material was round stock. Also, the location of the roll pin hole was moved 1/32".

Final Copy

Tally ✓ — Purchase — Est. Time to Complete Tools 2 to 3 weeks — Size Machined — Weight Required — Unit of Measure — Est. Tooling Cost $25.00 — Est. Completion Date of Op. Schedule — Tool Engr. A. Long — Date 5-3-55 — Process Engr. T.F. MacAleer — Date 5-1-55 — Remarks F137097 Drill Jig — Remarks Schedule made for forging

PRODUCTION — Quantity to Stock 300 — Qty. per Order 300 — No. of Months for Which Stock is Required 8 (1015 pcs) — Qty. Last Year — Date Started — Average Monthly Usage 130 — Annual Rate with Variation — Average Monthly Service Usage — Est. Lead Time 4 months - outside lead time 2 months - inside lead time — Cost Dept. W.C. Frech — Date 5-11-55 — Prod. Planner C. Crilly — Date 4-29-55 — Price Revised — Date — Remarks Forging information - 1200 - 30618 ordered 4-29-55 — Remarks Includes approximate actual overhead ([redacted])

600 wanted 9-1-55

600 wanted 1?-1-55

COST ACCUMULATION AND WORK WRITING — Material Cost 1.165 — Labor Cost .504 — Overhead Cost [redacted] — Total Cost [redacted] — Selling Price [redacted]

THE YALE & TOWNE MFG. CO.

Yale Materials Handling Division

Subject: Progress Report (10) Sets of Parts - 052-2024 Hydraulic Gas Truck

Date: March 19th, 1954

To: Mr. B. A. Moski, Dir. of Ind. Engr.

From: Chief Process Engineer

cc: Mr. J. T. Mc Carley, Mr. P. A. Metzger, Mr. O. S. Carliss, Mr. G. F. Quayle, Mr. G. A. Wulf, Mr. T. W. Curtin, Mr. C. E. Moore, Mr. H. H. Amberg, Mr. M. P. Ryan, Mr. H. P. Brackin, Mr. T. H. Olson, File

The following report for week ending March 19th, 1954, I believe, will give you the necessary information as to the progress of subject trucks.

Design Status

	Unit $	% Completion
Drive Unit Assembly	26	22
Trailing Axle Assembly	6	6
Frame	15	15
Channel & Carriage Assembly	20	20
Steering Unit	2	2
Hydraulic System, Controls, Instruments, Wiring	8	
Parking Brake	2	2
Counterweight	1	1
Misc. Parts & Assemblies	20	.15
% Completion of Initial Pilot Design	100%	85%
Est. Completion Date of Pilot Design	4-5-54	

19 - New Items have been received during the week ending 3-19-54.
14 - Revisions have been received during the week ending 3-19-54.

These revisions originated in Tool Design, Process Engineering, and Product Engineering. All have been followed through Purchasing, Manufacturing, etc., and operation schedules have been changed to correspond.

NOTE: In our last progress report dated 3-12-54, we stated that Engineering Design was complete with not more than 30 items as yet to be released. However, the above releases indicate that there are still more items required to complete the design.

It is evident that until all parts required, and anticipated Revisions are released, we are seriously handicapped in determining an accurate completion date. This is especially true since the latest releases involved (2) new castings.

Page 1 of 5 pages

"BIRTH CERTIFICATE" (above) of revised part lists all pertinent information for production cost accounting and industrial engineering divisions. Progress Report (below) written by methods engineer informs management and department heads of status of each project.

FLUID TRANSMISSION

In High Pressure Systems

WALTER ERNST

Vice President and Director of Engineering,
The Commonwealth Engineering Company of Ohio

An amplification of Joint Industry Conference recommended standards for piping, tubing, flared and flareless fittings, pipe threads, AN straight connectors, hose and hose fittings, and flanged and welded connections to be used as a practical guide in the design of industrial hydraulic equipment.

A HYDRAULIC SYSTEM may be defined as a system of power transmission in which an incompressible fluid is used as the power transmitting medium. Hydraulic systems, as generally understood in mechanical technology, deal with pressure energy (positive displacement hydraulic power).

Transmission of hydraulic energy is analogous to an electrical system in that it requires generators, motors and transmission lines. As in electrical energy transmission, design and capacity of hydraulic transmission lines are determined by the energy level. The latter is defined by the product of flow and pressure.

Pressures employed in hydraulic systems range from a few pounds per square inch to 10,000 psi and higher. Definition of hydraulic pressures has been established by the Joint Industry Conference (JIC Hydraulic Standards for Industrial Equipment, General Motors Corp., Detroit, 1953). There are five classifications, as follows:

Low—0 to and including 200 psi
Medium—above 200 to and including 500 psi
Medium high—above 500 to and including 1,200 psi
High—above 1,200 and including 3,000 psi
Extra high—above 3,000 psi

While the majority of present-day applications fall into the medium high classification, there is a definite trend towards higher pressures, so that a consideration of design practices for the high pressure classification assumes increasing importance. Much of the data given here on transmission systems in the high pressure range may be used for the extra-high classification which is finding many proponents.

JIC SPECIFICATIONS FOR TRANSMISSION LINES

It is desirable that all fluid transmission systems follow the recommendations of the Joint Industry Conference. Section H4 of this standard includes general recommendations for fluid transmission lines and specific recommendations for tubing and piping installations. The general recommendations deal broadly with adequate size of piping and design safety factors (section H4.1.3), minimum volume of fluid (section H4.1.5), cleanliness (section H4.1.7), support (section H4.1.8), accessibility (section H4.2.6), identification (section H4.4.1) and protection in shipment (section H4.4.2).

TUBING AND FITTINGS

Two systems are in use for denoting sizes of fluid power transmission lines, defined as tubing and piping respectively. The older system, still in extensive use, defines conduit by inside diameter, so-called pipe sizes. In contrast, tubing is defined by outside diameter and wall thickness.

The JIC hydraulic standard, section H4.1.6, establishes standard tubing diameters in inches as follows:

from $\frac{1}{8}$ to $\frac{3}{8}$	outside diameters to increase in increments of 1/16
from $\frac{1}{2}$ to 1	outside diameters to increase in increments of $\frac{1}{8}$
from $1\frac{1}{4}$	outside diameters to increase in increments of $\frac{1}{4}$

Physical and chemical properties as well as manufacturing tolerances are also covered and tubing may be purchased from manufacturers in conformity with the appropriate section of the JIC standard.

It should be noted that copper tube and copper alloy fittings may not be used with petroleum base fluids (JIC

Table I—Tube Wall Thickness by Gage Number

Birmingham or Stub's Iron Wire Gage Size No.	Equivalent Tube Wall Thickness in inches	Birmingham or Stub's Iron Wire Gage Size No.	Equivalent Tube Wall Thickness in inches
1	0.300	16	0.065
2	0.284	17	0.058
3	0.259	18	0.049
4	0.238	19	0.042
5	0.220	20	0.035
6	0.203	21	0.032
7	0.180	22	0.028
8	0.165	23	0.025
9	0.148	24	0.022
10	0.134	25	0.020
11	0.120	26	0.018
12	0.109	27	0.016
13	0.095	28	0.014
14	0.083	29	0.013
15	0.072	30	0.012

Fig. 1—Tube cutter. Recessed blade in handle permits deburring inner edge of tube. The Parker Appliance Co.

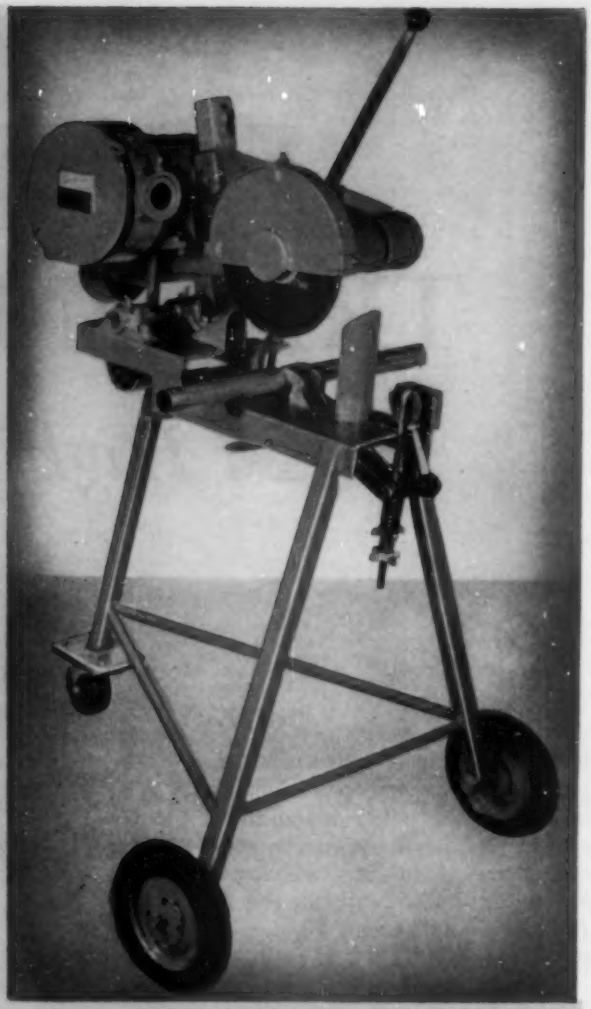


Fig. 2—Abrasive cut-off machine. The Wallace Tube Co.

Table II—Tube Diameters and Wall Thicknesses, Inches

Tube Diameters	Minimum Wall Thickness
to 3/8 incl.	0.060
1/2	0.075
5/8	0.095
3/4	0.109
7/8	0.109
1	0.120

standard section H4.1.6.3). SAE 1010 dead soft, cold drawn seamless steel tubing and steel fittings must be used (section H4.1.6.2).

Wall thickness of tubing must be selected to withstand the maximum rate of surge pressure rise and the maximum surge peak pressure at the frequency developed by the cycling of the equipment operation (JIC standard H4.1.4, B). A factor of safety of at least eight over normal working pressure is suggested (section H4.1.3).

Wall thickness required to contain the normal or design working pressure may be readily computed by means of the formula

$$t = \frac{PD}{2S}$$

where

t = minimum tube wall thickness, in.
P = design working pressure, psi
D = outside diameter of tube, in.
S = allowable tensile stress of materia psi

The formula is not theoretically rigorous, but adequate for practical purposes.

Wall thickness of tubing is denoted by Birmingham or Stub's iron wire gage shown in Table I. However, tubing may also be purchased in certain sizes with wall thickness expressed in fractional inches. Not all gages are carried in all tube sizes by suppliers, and specifications for hydraulic systems should take this fact into consideration.

Transient or surge pressures are difficult to estimate and seldom appreciated in their full potential magnitude. Actual experience has shown that transients of two to four

times maximum design working pressure are not uncommon and often not suspected by the designer. Where detailed information on the transient pressures is unavailable, suitable safety factors should be provided. These safety factors should be related to the endurance limit, not to the ultimate strength of the material.

In addition to normal working pressures and surge peaks there may be mechanical stresses produced by thermal expansion, elastic yield of supporting structures, abuse by personnel, etc. Evaluation of all the phenomena is difficult, so that proper dimensioning of piping wall thickness becomes a matter of experience.

JIC recommendations may serve as a design guide. For high pressure applications (1,200 to 3,000 psi), minimum wall thicknesses listed in Table II are recommended.

These JIC recommendations imply the use of flared or flareless fittings when tube connections are to be made. For larger tubing or piping, welded flanged fittings may be employed.

Threaded piping or tubing for direct connection to components is not permitted under the standard and should never be resorted to on any high pressure hydraulic installation. (See JIC section H4.1.9.)

Connection between components should be made by employing the minimum number of joints and the use of elbows and the like should be avoided. This, together with preparation of the ends for attachment to fittings calls for fabrication techniques of cutting, bending and flaring. For additional information on these techniques the reader is referred to the publications listed at the end of this article.

Tubing may be cut with a hacksaw, but a better job may be done with a tube cutter like the one shown in Fig. 1, which produces clean square ends.

On production jobs a recently developed abrasive cut-off machine (Fig. 2) will render good service. Machines have been developed to cut tubing and pipe from the smallest to the largest sizes and of any desired wall thickness. Some of the abrasive cut-off machines incorporate deburring devices.

The bending of tubing is dependent upon proper equipment. For the ordinary bending jobs, involving tubing up to one inch in diameter, hand benders are frequently used. Fig. 3 illustrates a typical design. The principle is simple; the tube is pulled around a stationary form by means of a sliding bar. Each size of tubing requires, of course, a different bender. For the hand tube bender illustrated in Fig. 3, the radii listed in Table III are standard. Hot bending by hand is also resorted to in special cases, such as small radius bends on heavy tubing. This work may be handled on tables equipped with a series of removable pins by heating the tubing with a torch. The tubes are usually filled with a supporting material to make the bend smooth. For any kind of production bending specially designed equipment is recommended.

Fig. 4 shows a manually operated production bender. This tool is

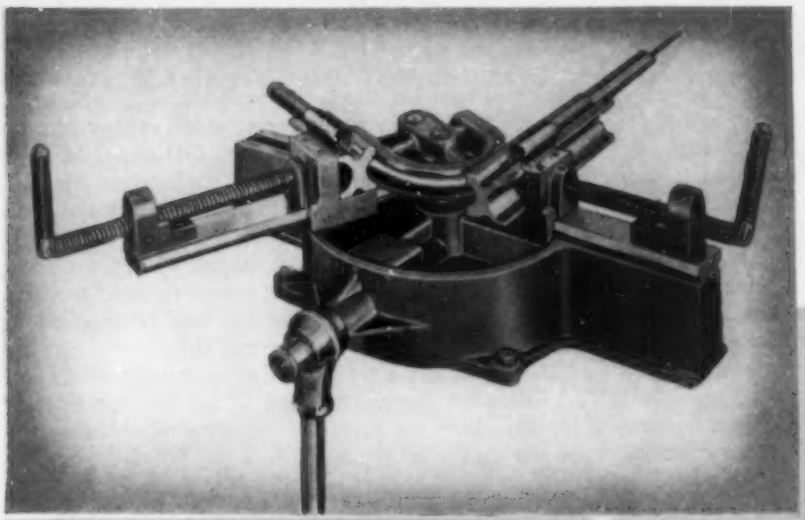


Fig. 4—Production tube bender. Clamp blocks and radius may be changed for different size tubes. The Parker Appliance Co.

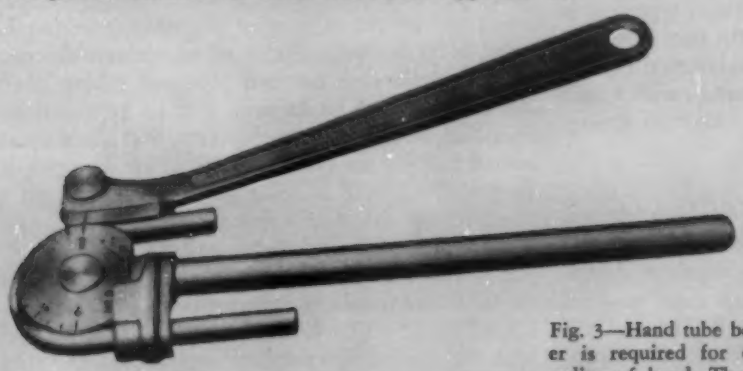


Fig. 3—Hand tube bender. A different bender is required for each size of tube and radius of bend. The Parker Appliance Co.

Table III—Standard Tube Bend Radii, Inches

No.	
2	for ⅛ OD tube (⅜ rad.)
3	for $\frac{3}{16}$ OD tube ($\frac{9}{16}$ rad.)
4	for ¼ OD tube ($\frac{3}{4}$ rad.)
5	for $\frac{5}{16}$ OD tube ($\frac{15}{16}$ rad.)
6	for ⅜ OD tube (1⅛ rad.)
8	for ½ OD tube (1½ rad.)
10	for ⅝ OD tube (2 rad.)
12	for ¾ OD tube (2½ rad.)
14	for ⅞ OD tube (3 rad.)
16	for 1 OD tube (3½ rad.)

All radii to center line of tube.

Fig. 5—Power flarer. The Parker Appliance Co.

Table IV—Tube Radii and Wall Thicknesses Without Mandrel, Inches

Standard radii.....	1¼	1¼	1½	1¾	2	3
Tube Outside Diameter.....	⅜	½	⅝	¾	⅞	1
Wall Thicknesses..	0.03	0.04	0.045	0.055	0.070	0.075

Table V—Pipe Threads

Pipe Size, in.	Outside Diameter, in.	Length of Thread Screwed into Fitting, in.	Thread per in.	Taper, in. per ft
⅛	0.405	¼	27	¾
¼	0.540	⅜	18	¾
⅜	0.675	⅜	18	¾
½	0.840	½	14	¾
¾	1.050	½	14	¾
1	1.315	$\frac{9}{16}$	11½	¾

suitable for steel tubing ⅜ to 1 in. OD. Construction of bender permits changing radius, clamp, and slide blocks, for each size of tubing and bend radius required. In this type of bender the tube is clamped to the rotatable form by the clamp block and held against the form by the slide block. As the form is rotated, the tube will be forced around its perimeter, being restrained and held against the form by the slide block. Since the stationary end of the tube remains in a straight line, a mandrel may be mounted on a straight rod and used to support the pipe to prevent its collapse.

Standard radius blocks provide for the tube sizes listed in Table IV to be fabricated on this production bender without a mandrel. A larger machine is offered for bending light gage steel tubing up to 2½ in. OD.

When flared type tube fittings are used, it will be necessary to flare the end of the tubing.

Hand flaring may be accomplished by hammer type and combination type of flaring tools. A hammer type tool is designed for one size of tubing only and the flare is formed by hammer blows on the flaring pin. Combination type of flaring tools accommodate a range of diameters with a split die. Fig. 5 illustrates a power flarer for production flaring.

JIC FLARED FITTINGS

Fittings are used to connect the ends of tubing to components and to produce elbows, tee and cross connections. JIC Hydraulic Standard, section H4.1.6, regulates design and performance of tube fittings. Fittings must pass requirements of Federal specification MIL F-5506 and are dimensionally identical with aircraft fittings with exception of thread tolerances.

Fittings are cataloged by several manufacturers whose complete dimension sheets are available to the designer. They are available in a number of combinations of pipe sizes and tube diameters, up to 2 in. OD and 2 in. pipe thread, although for high pressure applications the JIC standard restricts their use up to and including one inch OD tubing. A variety of styles, such as male and female connectors, unions, elbows, both 90 and 45 deg, male and female and union type as well as several styles of tees and crosses are available. Special fittings may be supplied to reduce tubing branches one or several sizes.

Fig. 6 illustrates a typical design of straight connector. This fitting has the JIC specified 37 deg flare and features a support sleeve for the tube, which avoids rotating the tube nut on the tube proper.

PIPE THREADS, STANDARD AND DRY SEAL

Pipe thread size originally referred to the inside diameter of a pipe to whose outside diameter the thread was applied. Since the advent of heavier pipe this definition has lost some of its meaning, so that for an accurate determination of the relationship between pipe and tubing size several dimensions must be known. For an approximate determination we may assume, however, that the nominal pipe size of a fitting denotes the pipe's inside diameter, and the proper size tubing to mate would then have an outside diameter equal to the pipe size plus twice the wall thickness, or rather the nearest standard outside diameter. Using JIC recommended wall thicknesses, for instance, a ⅛ in. pipe thread fitting should be mated with a ¼ in. tube, a ¼ in. pipe thread fitting with a ⅜ in. tube, etc. This method will work with the smaller size combinations of pipe and tube sizes, however, the tendency of most suppliers of fittings is to combine pipe and tubing that are nominally equal in the

larger sizes. For example, 1¼ in. fittings (having 1¼ in. pipe thread) are offered with a 1¼ in. tube.

In dimensioning a tubing system, safe practice dictates the establishment of the tube inside diameter as criterion for flow velocity. Pipe sizes range from ⅛ in. in eighths to ¾ in., then in quarters to 1½ in., then in halves over 1½ in. (A ⅞ in. pipe thread, based on AN standards, has recently been introduced, but fittings for that size are obtainable only on special order.)

Pipe thread dimensions are based on American Standard ASA-B2 and in Table V the most important dimensions are given for threads up to one inch. For full details the reader is referred to the source.

Under JIC Standard the use of Dryseal American (National) Standard Taper Pipe Threads is mandatory. Dryseal pipe threads differ from National Standard pipe threads by engaging roots and crests before flanks, so that spiral clearance occurring in standard threads is avoided. Special taps for tapping components are required.

FLARELESS FITTINGS

Higher pressures have rendered the flaring of fittings more critical. Efforts have been made toward elimination of the flaring operation for heavy steel tubing. The result is the appearance of the "flareless" tube fitting of which there are several representatives. Fig. 7 shows the "Ferulok" connector marketed by the Parker Appliance Co. Ferulok fittings, like flared fittings, are available in a variety of sizes and styles. They are particularly well suited with heavy walled steel tubing in high pressure systems. The Ferulok fitting meets all JIC, SAE and ASME standards. The Ermeto fitting offered by Weatherhead employs the same principle.

The Lenz fitting employs an O-ring to seal the tubing in the fitting and a split collet to hold the tube. It is adaptable to thick and thin walled tubing and requires a very light wrench torque, as it seals with pressure on an O-ring.

AN STRAIGHT CONNECTORS, O-RINGS AND BACK-UP WASHERS

As pointed out previously, there is no exact relationship between nominal pipe sizes and tubing diameters, therefore, this relationship must be established for individual designs by proper selection and mating of tube and pipe sizes. Since the pipe thread is tapered, the location of a fitting in relation to the component cannot be accurately predicted, which is often objectionable. Tightness of pipe threads depends on good workmanship and finish.

Attempts have been made to supplant pipe threading with more acceptable methods. One solution is used for aeronautical fittings in which the fitting nose is threaded into the component and sealed with an O-ring.

Fig. 8 shows this method used with a "bulkhead" type of connector, which must be used in places where an elbow connection is required. For straight connections a large hex union connector is required with a hexagon of sufficient size to accommodate the O-ring and back-up ring.

The same scheme is being used extensively for industrial installations and approved under section H4.1.6.F. Fig. 9, reproduced from AND 10050, shows the principal dimensions for tube fitting nose threads, except ⅞ in. which is not listed in the AN standard, although used under JIC standard. Industrial fittings for ⅞ in. tube are listed in the manufacturers' catalogs.

O-rings are AN 6290 and may be called out under dash numbers corresponding to tube diameters in sixteenth inches. An AN 6290-6 O-ring is one for a ⅜ in. OD tubing straight threaded (⅞ in.-18) tube fittings.

Back-up rings (required for high pressure installations) are AN 6291 and may be called out similarly. Bulkhead

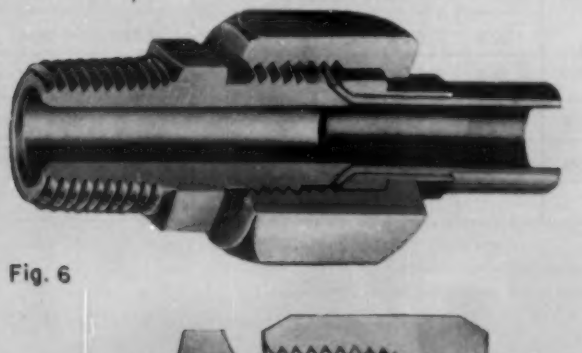


Fig. 6

Fig. 6—Triple-Lok tube connector. The Parker Appliance Co.

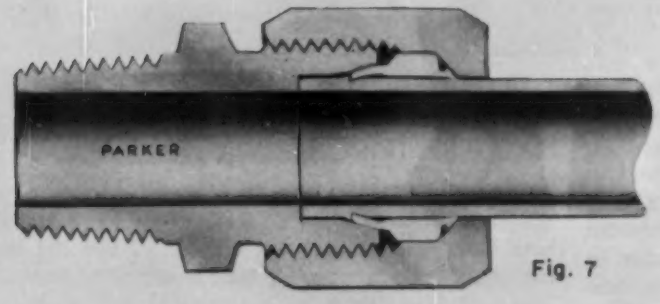


Fig. 7

Fig. 7—Ferulok tube connector. A flareless connector particularly suited to heavy walled steel tubing. The Parker Appliance Co.

Fig. 8—AN bulkhead connector with 0-ring seal.

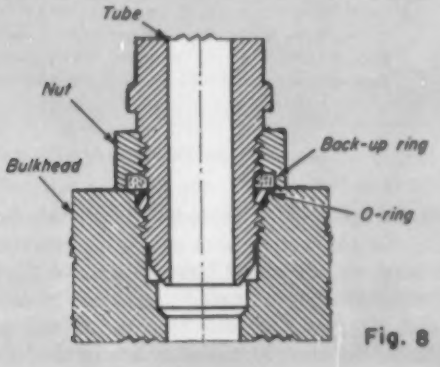
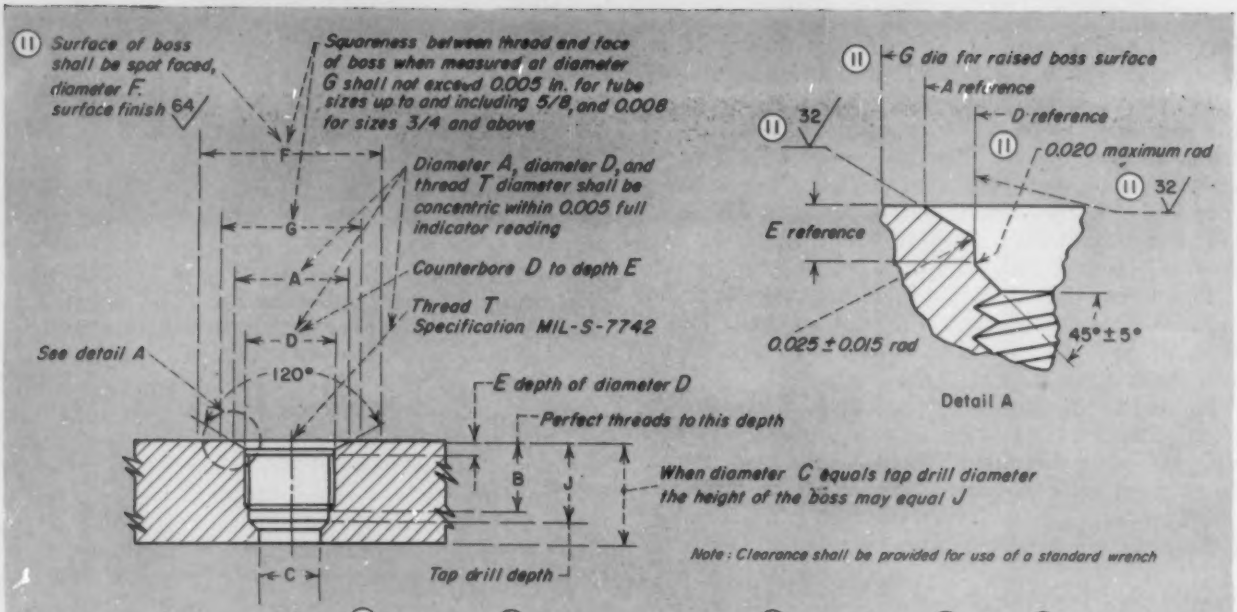


Fig. 8


(11) Surface of boss shall be spot faced, diameter F, surface finish 64
Squareness between thread and face of boss when measured at diameter G shall not exceed 0.005 in. for tube sizes up to and including 5/8, and 0.008 for sizes 3/4 and above
Diameter A, diameter D, and thread T diameter shall be concentric within 0.005 full indicator reading
Counterbore D to depth E
Thread T Specification MIL-S-7742
See detail A
120°
E depth of diameter D
Perfect threads to this depth
When diameter C equals tap drill diameter the height of the boss may equal J
Tap drill depth
Note: Clearance shall be provided for use of a standard wrench
(11) G dia for raised boss surface
A reference
D reference
(11) 0.020 maximum rad
(11) 32
(11) 32
E reference
0.025 ± 0.015 rad
45° ± 5°
Detail A

Equivalent tube size dash No.	Tubing OD	Thread T	A +0.015 −0.000 Dia	B Min	C Min Dia	D +0.005 −0.000 Dia	E +0.015 −0.000	F Min Dia	G Min Dia	J Min
2	1/8	5/16-24 UNF-3B	0.438	0.375	0.062	0.328	0.063	0.672	0.562	0.500
3	3/16	3/8-24 UNF-3B	0.500	0.406	0.125	0.390		0.750	0.625	
4	1/4	7/16-20 UNF-3B	0.562	0.438	0.172	0.454	0.075	0.828	0.688	0.594
5	5/16	1/2-20 UNF-3B	0.625		0.234	0.517		0.906	0.750	
6	3/8	9/16-18 UNF 3B	0.688	0.469	0.297	0.580	0.083	0.969	0.812	
8	1/2	3/4-16 UNF-3B	0.875	0.562	0.391	0.769	0.094	1.188	1.032	0.718
10	5/8	7/8-14 UNF-3B	1.000	0.625	0.484	0.896	0.107	1.344	1.157	0.781
12	3/4	1-1/16 12 UN -3B	1.234	0.688	0.609	1.086	0.125	1.625	1.406	0.906
16	1	1-5/16-12 UN 3B	1.487		0.844	1.336		1.910	1.656	0.938
20	1-1/4	1-5/8-12 N -3B	1.800		1.078	1.648		2.270	1.969	0.984
24	1-1/2	1-7/8-12 N 3B	2.050	0.750	1.312	1.898		2.560	2.219	1.125
28	1-3/4	2-1/4-12 UN -3B	2.425	0.812	1.547	2.273		3.010	2.294	1.250
32	2	2-1/2-12 UN -3B	2.675	0.938	1.781	2.524		3.480	2.844	1.375

(11) Finish: For surface roughness, see standard MIL-STD-10.
The countersink to diameter A and counterbore to diameter D shall be free from longitudinal and spiral tool marks.
(11) Break all sharp edges and remove all hanging burrs and slivers which might become dislodged under usage.
Dimensions in inches. Unless otherwise specified, tolerances: angles ± 1/2°.

Fig. 9—Standard Air Force-Navy dimensions for gasket seal straight thread bosses.

elbow unions come equipped with suitable hex nuts for making the connection from several manufacturers.

At least one supplier (Parker Appliance Co.) is already producing straight threaded bulkhead type fittings for use with O-rings. Tapered pipe thread will probably be supplanted by straight threaded fittings and O-rings, possibly less complex than indicated on AND 10050.

HOSE AND HOSE FITTINGS

JIC section H4.2.4 calls for a safety factor of five for flexible hose. This requires the use of double wire braided hose for high pressure service. Table VI lists the important data for high pressure double wire braided hose.

Hose may be attached to tubing, fittings or components

with suitable fittings. Reusable hose fittings have superseded practically all other means of connecting hose. They are being offered by several manufacturers.

Four types of end connections are available; swivel type tube nut (to connect to tube end of standard tube fitting), male tube thread fitting, male pipe thread and female pipe thread. The four types may be applied to the two ends of a hose section in any desired combination. Within each style a selection of pipe or tube sizes (listed in Table VII) may be mated with a given hose size.

Recently, quick disconnect hose couplings have been developed with or without automatic shut-off for one or both sections.

A few simple rules must be observed when installing hose. Hose should not be bent smaller than minimum specified bend radius or be twisted in installation. There should always be at least one swivel connection. Straight runs between parallel walls must be avoided; hose should be looped and elbow fittings installed. Hoses are not nearly as flexible as the novice is inclined to believe.

Table VI—High Pressure Hose Data

Inside Dia., in.	Outside Dia., in.	Burst Pressure, psi	Working Pressure, psi	Min. Bend Rad., in.
¼	11/16	18,000	3,600	4
3/8	27/32	14,000	2.800	5
½	31/32	12,000	2,400	7
¾	1¼	9,000	1,800	9½
1	1 5/16	7,500	1,500	11
1¼	2	6,500	1,300	16
1½	2¼	5,000	1,000	20
2	2¾	4,000	800	22

Table VII—Combinations of Hose, Tube and Pipe Thread Diameters

Hose Diameter (Inside), in.	Tube Diameter (Outside), in.	Pipe Thread, in.
¼	¼, 5/16 or 3/8	⅛ or ½
3/8	3/8 or ½	¼ or 3/8
½	½ or 5/8	3/8 or ½
¾	¾	¾
1	1	1
1¼	1¼	1¼
1½	1½	1½
2	2	2

Table VIII—Dimensions of Schedule 160 Pipe

Size, in.	Outside Dia., in.	Inside Dia., in.	Wall Thickness, in.	Inside Area, sq in.
½	0.84	0.466	0.187	0.171
¾	1.05	0.614	0.218	0.208
1	1.315	0.815	0.250	0.522
1¼	1.660	1.160	0.250	1.060
1½	1.900	1.338	0.281	1.410
2	2.375	1.689	0.343	2.250
2½	2.875	2.125	0.375	3.55
3	3.500	2.626	0.437	5.41
4	4.500	3.438	0.531	9.32
5	5.563	4.313	0.625	14.65
6	6.625	5.189	0.718	21.20
8	8.625	6.813	0.906	36.70

FLANGED AND WELDED CONNECTIONS

JIC standard recommends the use of welded flange fittings or approved equivalent for high pressure installations over one inch diameter. In some high and for all extra high pressure installations, flanged fittings are advisable for smaller size tubes down to ½ in. diameter. Flanged fittings may be provided for tubing, proceeding in increments of ½ in. in dia according to JIC section H4.1.6. However, the majority of installations are still made with piping, with outside diameter in accordance with ASA standard B2.

There has not been a standardization of flanged fitting practice or dimensioning comparable to that of tube fitting practice. Present ASA standard flanges appear to be of too obsolete design to be considered for this purpose and a review of the entire problem seems indicated. In the meantime, manufacturers of hydraulic components follow their own design philosophy, which sometimes results in a heterogeneous assembly when components of different makes are on one installation.

Common trends are toward four bolt flanges of rather heavy section, employing sealing devices that seal with pressure (mandatory JIC section H4.1.9). Alloy steel cap screws or bolts are used to fasten the flange to the components to achieve a compact installation. The pipe is attached by welding in a prepared socket or to a spigot or welding neck.

Flanged fittings are designed around the component inlet and sealing means. Logically the component inlet should be equal to the inside diameter of the pipe. Inside diameters of schedule 160 pipe are given in Table VIII. The seal should be designed so that its inside diameter will clear the component inlet with minimum clearance, as the size of the seal determines the dimensions of the entire fitting.

There still is some divergence of opinion whether the seal should be "captive," that is, confined on both ID and OD or whether they should be confined on OD only. A captive ring can never get out of its location and find its way into the hydraulic system, but the construction is expensive and tends to increase the size of the fitting. Fig. 10 illustrates both conditions. The component inlet diameter is carried through the fitting above the seal, then the counterbore, equal to the outside diameter of the pipe (plus clearance) is bored with a suitable chamfer for welding. A "J" chamfer, as shown in Fig. 10, is preferred over a Vee, as it enables the welder to make a good fused joint at the bottom of the chamfer.

The height or thickness of the fitting should be sufficient to prevent deflection under pressure that may cause the seal to blow out. A rough guide would be a thickness of ½ in. plus the nominal pipe diameter for a straight outlet, and one inch plus the actual outside diameter for a side outlet.

O-rings seals have supplanted other designs because of their low cost and simplicity. O-rings of constant section (⅛ in.) corresponding to AN 6230B will be found suitable. They are available in increments of ⅛ in. in diameter.

Flanges may be bolted with alloy cap screws of either

socket or hex head type. The size of the screws must be determined by computation of stresses caused by internal hydrostatic pressures acting against an area corresponding to the outside diameter of the seal, plus pressure transients and mechanical stresses. Bolt sizes are, therefore, determined as much by considerations of practical experience as by theoretical computations.

Spacing of the screws must be carefully chosen to avoid interference of the heads with the welding bead. Too close a spacing of the screws will require time consuming chipping of the weld for clearance, while too wide a spacing permits excessive deflection and adds unnecessary weight.

A more or less standardized line of flanged fittings, arranged for welding tubing outside diameters (or threading pipe), may be secured from Vickers, Inc. who will supply dimension sheets for the guidance of the design engineer.

PIPING SIZES AND SCHEDULES, WALL THICKNESSES

Piping was originally classified by weight as "standard," "extra heavy" and "double extra heavy." This classification has been superseded by classification according to schedule numbers. For hydraulic systems only hot or cold drawn seamless pipe may be used, which must be free of rust, scale and dirt on the inside.

Schedule numbers run from schedule 40 (formerly standard) to schedule 80 (formerly extra heavy) to the new classification of schedule 160. Double extra heavy pipe is still occasionally used. For high pressure systems schedule 160 pipe is recommended. This pipe is available in sizes from ½ to 8 in. Table VIII lists dimensions of schedule 160 pipe.

FORGED FITTINGS, UNIONS AND CONNECTIONS, WELD ELLS AND TUBE TURNS

Pipes are socket welded into flanged bolted fittings, as described above. A similar technique is used for connection to elbows, unions, etc. For this purpose forged fittings are available, bored and chamfered for welding. Elbows, tees, 45 deg ells and crosses in sizes from ½ to 4 in., bored for welding schedule 160 piping, may be obtained from several sources. Couplings, reducer and flanged unions are also available. A connection between pipes can, of course, also be made with flanged fittings.

In view of the difficulties encountered when bending the large and heavy piping, it is often advisable to buy a prefabricated bend and weld it into the line. These prefabricated bends may be supplied with a radius much smaller than the user could produce with his own equipment. These units, trade named "Weld Ells" or "Tube Turns," have chamfered edges and the exact inside and outside diameters of the corresponding pipe and can be welded to the pipe by butt welding, resulting in a neat and streamlined appearance. Fittings come in large or small radius models and tees are also available from various sources.

BENDING AND WELDING

Fabrication of the heavy, large size piping often offers special problems. Piping may be cut off with special equipment, as discussed above. Careful deburring of ends is required.

Hot hand bending of large pipe is frequently resorted to where the quantity involved does not warrant purchase of high priced equipment. To produce such hand bends, the pipe is filled with sand, the ends stoppered and then heated to a cherry red. A table is provided with holes into which pins may be inserted and the pipe is forced to bend around the pins to the desired radius by the use of chain falls, etc. Radii of less than three pipe diameters should be avoided.

A better and faster job can be done on bending machines of the power driven hydraulic type, if their installation is warranted. Ram and rotary types of bending machines are available.

A ram type machine is illustrated in Fig. 11. Its ad-

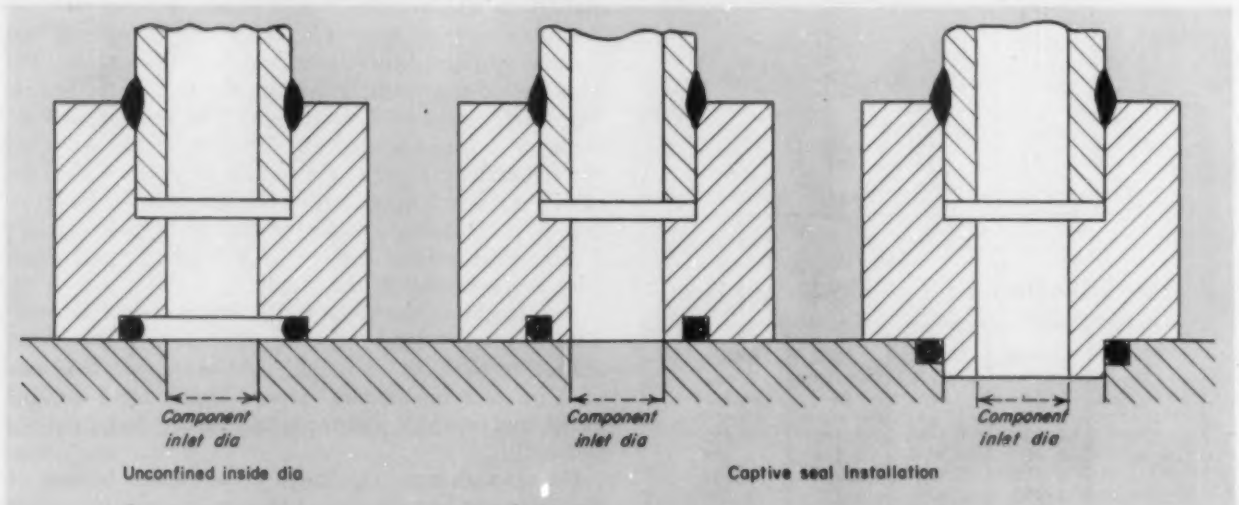


Fig. 10—Seal installations for bolted flanged fittings.

vantages are great flexibility and relatively low cost, however, it is difficult to do a perfect job of bending on this machine and it is not suitable for production.

In a rotary machine the pipe is clamped to a rotary die with a clamping die, and by rotation of the rotary die, is pulled around into the desired bend, being restrained by a stationary, pressure die. With this arrangement the free end of the pipe remains in a straight line and permits installation of a mandrel to support the pipe at the point of bending to keep it from collapsing. Bending machines are available for the largest and heaviest pipe likely to be encountered in hydraulic work. Fig. 12 illustrates a rotary bending machine suitable for up to 6 in. schedule 80 piping.

Pipes are welded into the sockets of fittings by the electric arc welding process. Dimensions for fillet welds are shown in Fig. 13. An alternate means, preferred for bolted and flanged attachment fittings would be a "J" chamfer in the fitting and a combined "J" and fillet weld, as illustrated in Fig. 10. JIC standard section H4.1.9 calls for stress relieving all welded joints.

To put up a satisfactory welded piping job, it is suggested to first tack weld the piping with the fittings in place on location and then remove and weld the assembly on the bench.

Several firms have helped in the preparation of this article with suggestions and useful printed matter which may be of aid to the reader. The Parker Appliance Co 17325 Euclid Ave., Cleveland 12, Ohio, supplied catalogs 4300, 4400, 4310B4, 5100, and Handbook No. 111. The Wallace Tube Co., 1300 Diversey Parkway, Chicago 14 Ill., have printed booklets "So You Want to Use Tubing," "The Cold Bending of Metals," and "Why Do Abrasive Cut-off Wheels Fail." Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich., provided installation drawing R-132140 and reference data 1221. The Oilgear Co., 1560 West Pierce St., Milwaukee 4, Wis., supplied Bulletin 90011-A The Watson-Stillman Co., Roselle, N. J., provided Bulletin A3, Edition 50. The Lenz Co., Box 1044, Dayton 1, Ohio, offered suggestions and information.

EDITOR'S NOTE—The above article is intended as a practical supplement to many of the more functional descriptions of hydraulic circuits which appeared in recent issues of *Product Engineering*.

"Theory of Hydraulic Flow Control" by Nils M. Sverdrup, April 1955, p 161, is a theoretical analysis of hydraulic resistance and flow rate of parallel and series circuits and flow control components.

"Hydraulics for High Horsepower Applications" by M. A Hayden, February 1955, p 129, describes the functional aspects of high pressure, high flow rate circuits and gives sample pump and motor size calculations.

Mr. Walter Ernst is the author of the book "Oil Hydraulic Power and its Industrial Applications" published by McGraw-Hill Book Co., Inc. in 1949. Now a classic in its field, this work is an excellent reference for the design engineer interested in using fluid power to drive machine components.

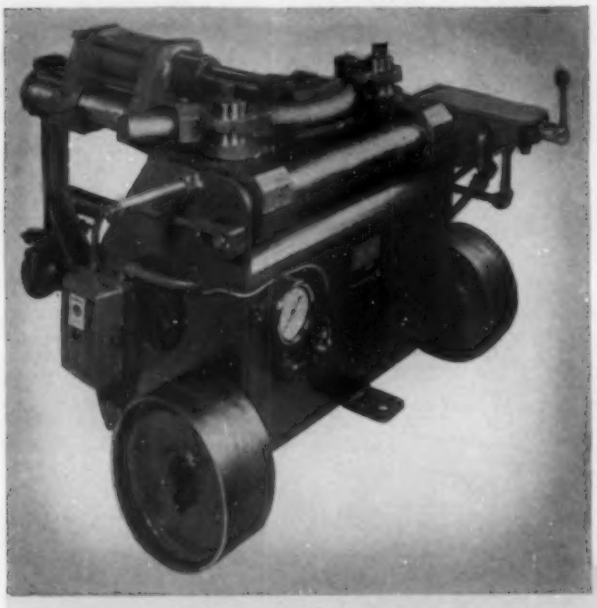


Fig. 11—Ram type hydraulic bender. The Wallace Tube Co.

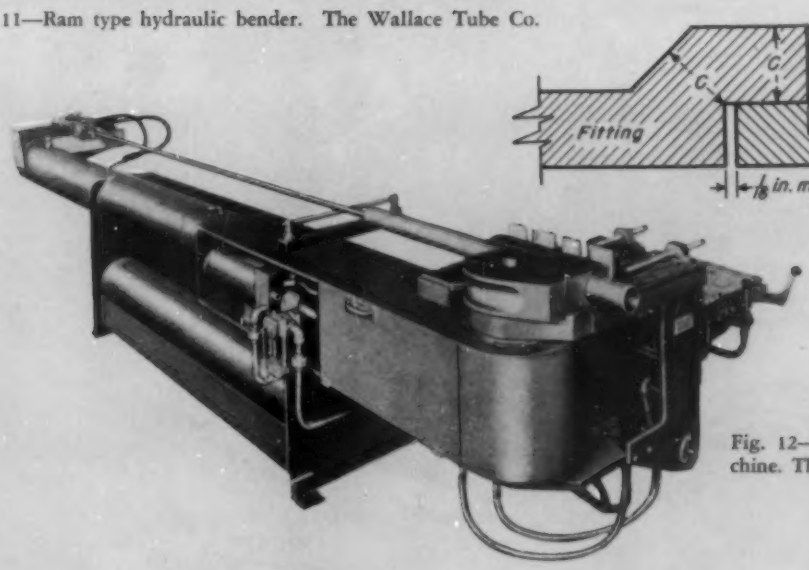


Fig. 12—Rotary bending machine. The Wallace Tube Co.

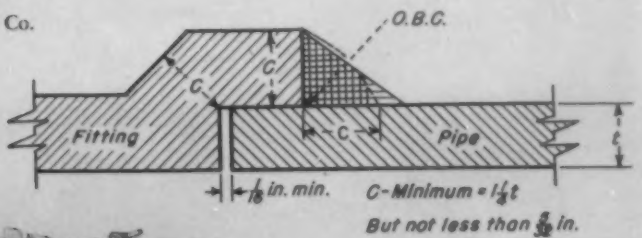
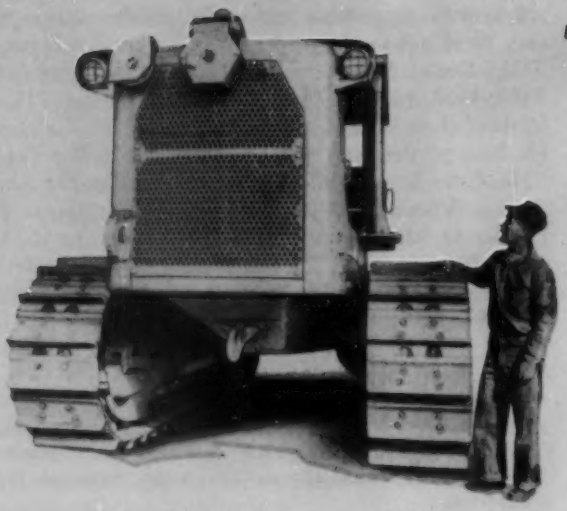


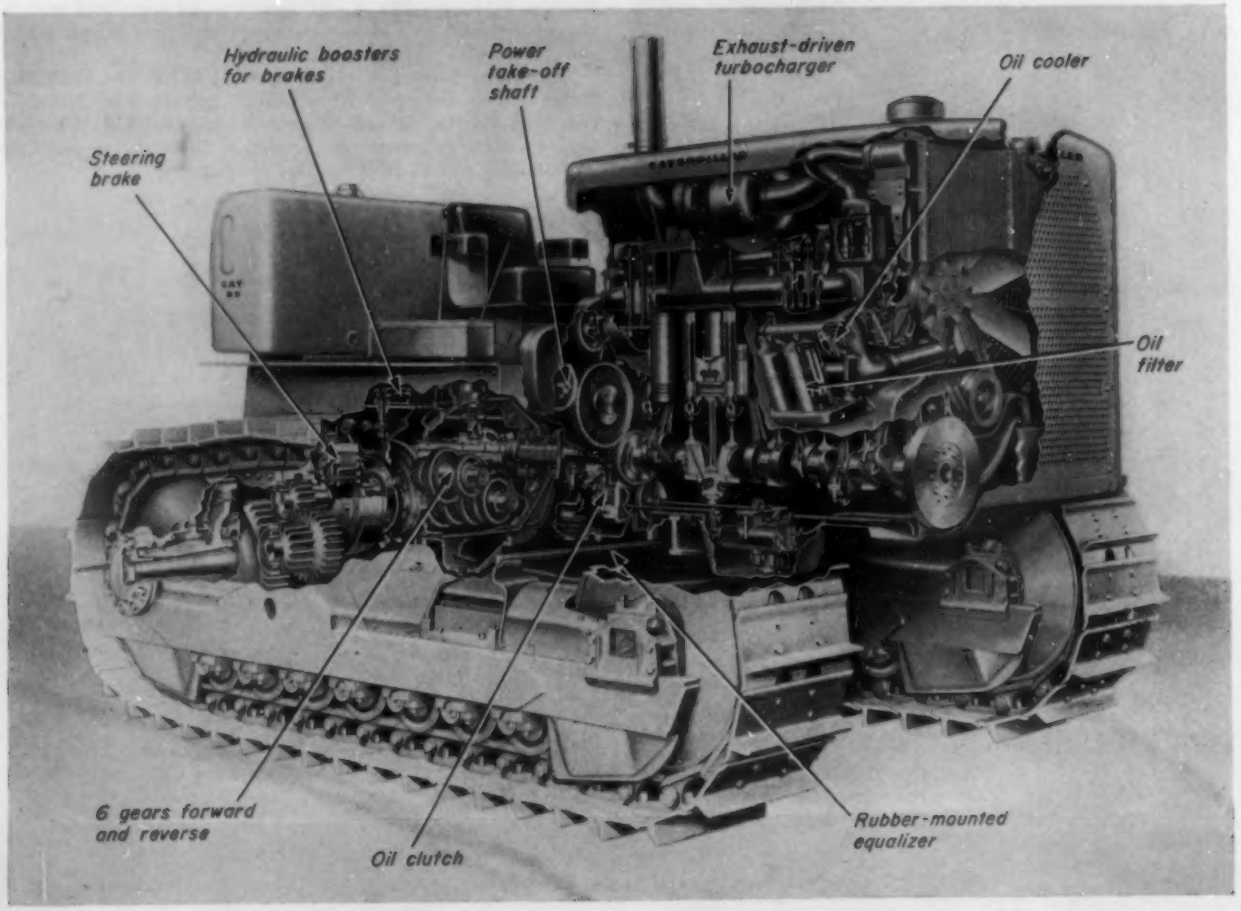
Fig. 13—Dimensions for fillet welds. The Watson-Stillman Co.



Turbocharged 286-hp

Development activity leading to the new Caterpillar D9 tractor started with studies of user needs and the power required for a larger tractor. Demand from the field was for units capable of eventually hauling more material per trip; faster loading of rubber-tired tractor-scraper units; agricultural needs in landforming and watershed protection called for more power; spoil bank levelling in mining was also creating a market for a bigger tractor.

Ultimately, market research put the question to sales as to how many 200-hp (drawbar) tractors



Diesel Drives New Track-Type Tractor

could be sold. The answer was encouraging, and some design parameters were set up.

Basic objectives were elimination of all field adjustments, infinite gear life, all assemblies directly demountable, and less work for the operator. Major problems faced were in developing a new 250-hp engine, a clutch capable of handling this power, effective sealing for the final drive, enough strength in the frame without excessive weight, and longer life for track shoes and rollers.

By 1950 some of these design problems were being

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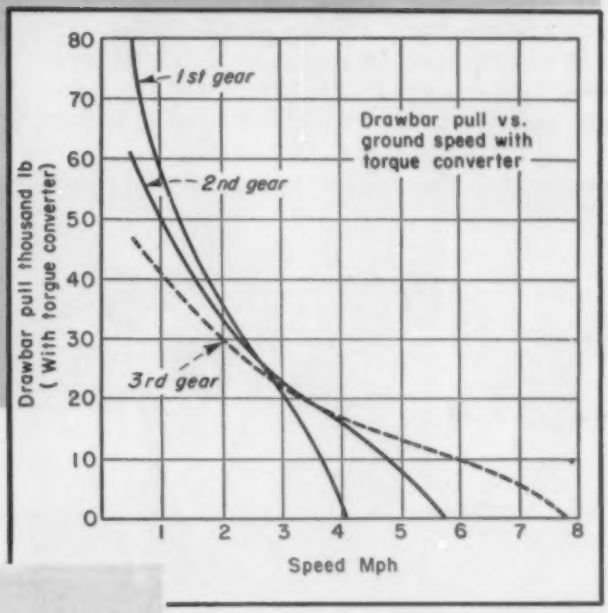
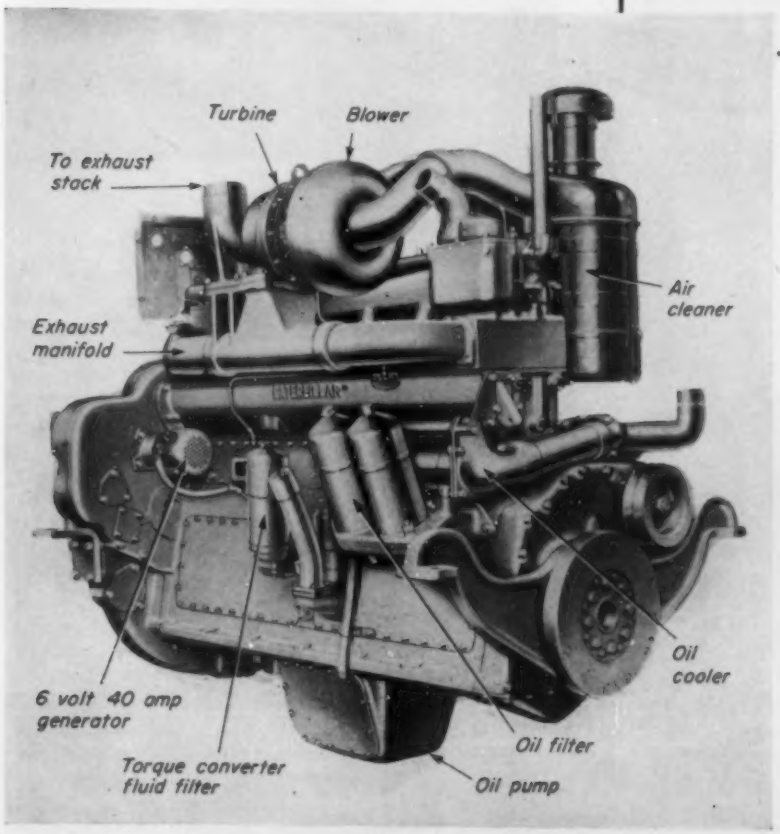


NEW CATERPILLAR D9 TRACTOR has a turbocharged 6-cylinder engine with 6¼ in. bore and 8 in. stroke, developing 286 hp at 1200 rpm, with 230 hp at the drawbar.



ALTHOUGH the tractor weighs 28 tons, the unit ground pressure is only 8 psi. Overall dimensions are approximately 18 ft long, 10 ft wide and 8¾ ft high.

A choice of two D9 models is available, one having a power-operated oil-type flywheel clutch with a 6-speed transmission, and the other a three-stage torque converter with a 5:1 torque ratio and a 3-speed transmission. Drawbar pull in low gear with the torque converter (see curve) can reach 80,000 lb. Turbocharger is driven by the exhaust, utilizing the exhaust gas energy instead of additional fuel.

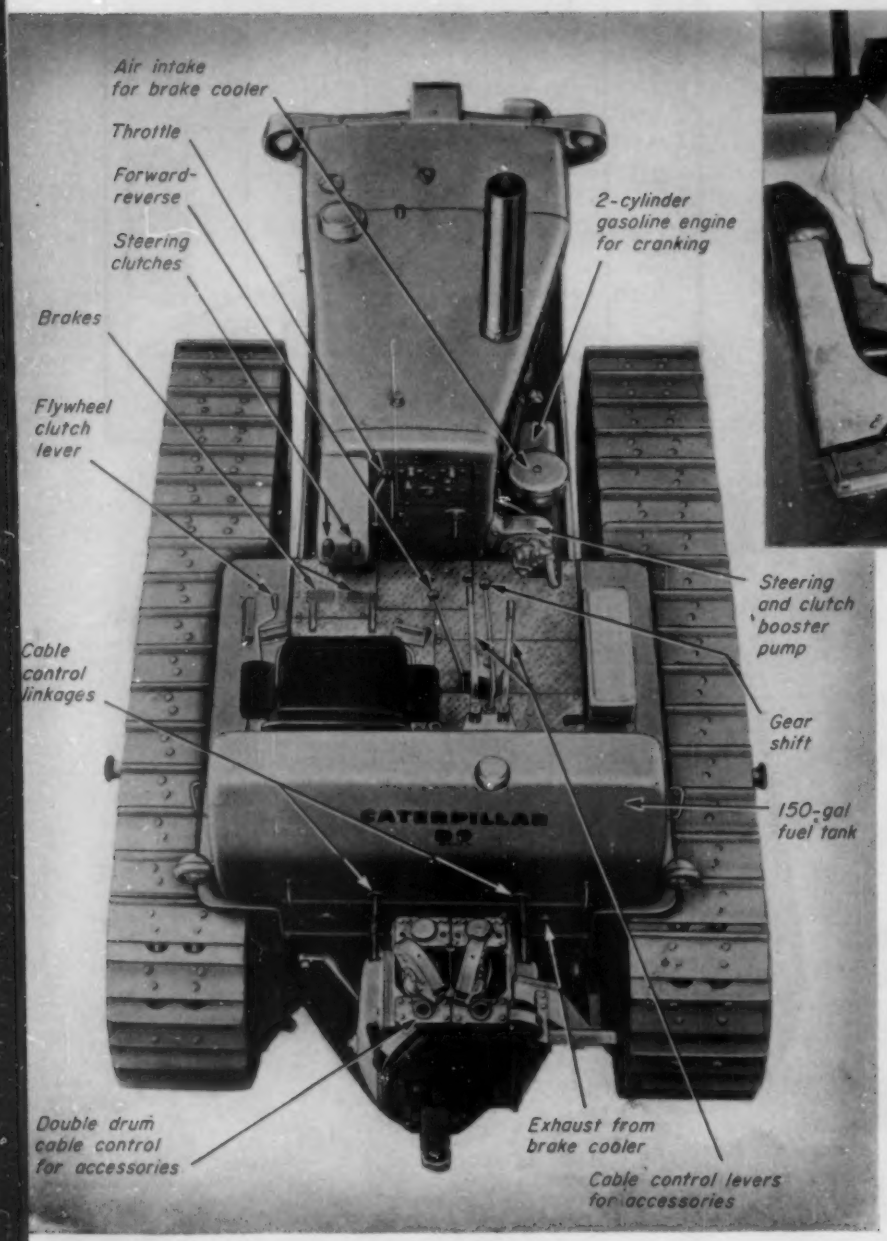
Lubrication for the engine is full flow with dual filters and an oil cooler is provided. Crankshaft is induction hardened on bearing journals; bearings are steel-backed aluminum alloy.

Track-Type Tractor (continued)

solved and final specifications began to take shape. Drawbar power was set at 200 hp net, with 15 per cent torque rise at 70 per cent speed. An oil-type flywheel clutch was designed. Some new ideas in seals had been developed; more extensive use was made of filters. Weight was set at 50,000 lb (minimum) with 120 in. maximum shipping width and 20 in. ground clearance. Power boosters were developed for control of flywheel clutch, steering clutches and brakes. Push button starting was obtained with a battery-started auxiliary gasoline engine.

Development was far enough along in 1952 for a wood mock-up, and a little later a working prototype, and then a second model incorporating further ideas. Additional changes came during the following months of field testing, and finally ten were built in 1954 for actual field use. This experience brought a few more detail changes such as larger brakes with forced air cooling, final drive gear with a different pitch, improved visibility for the operator, and the addition of an exhaust-driven turbocharger.

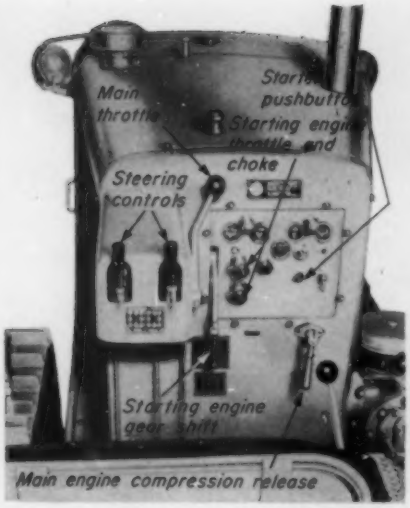
Along with design development, there were substantial problems in plant facilities and machinery to handle larger and heavier parts, and tooling which was substantially all new and on a scale in keeping with the increased size of the tractor. All factors worked together to put the new D9 tractor into production in May 1955.



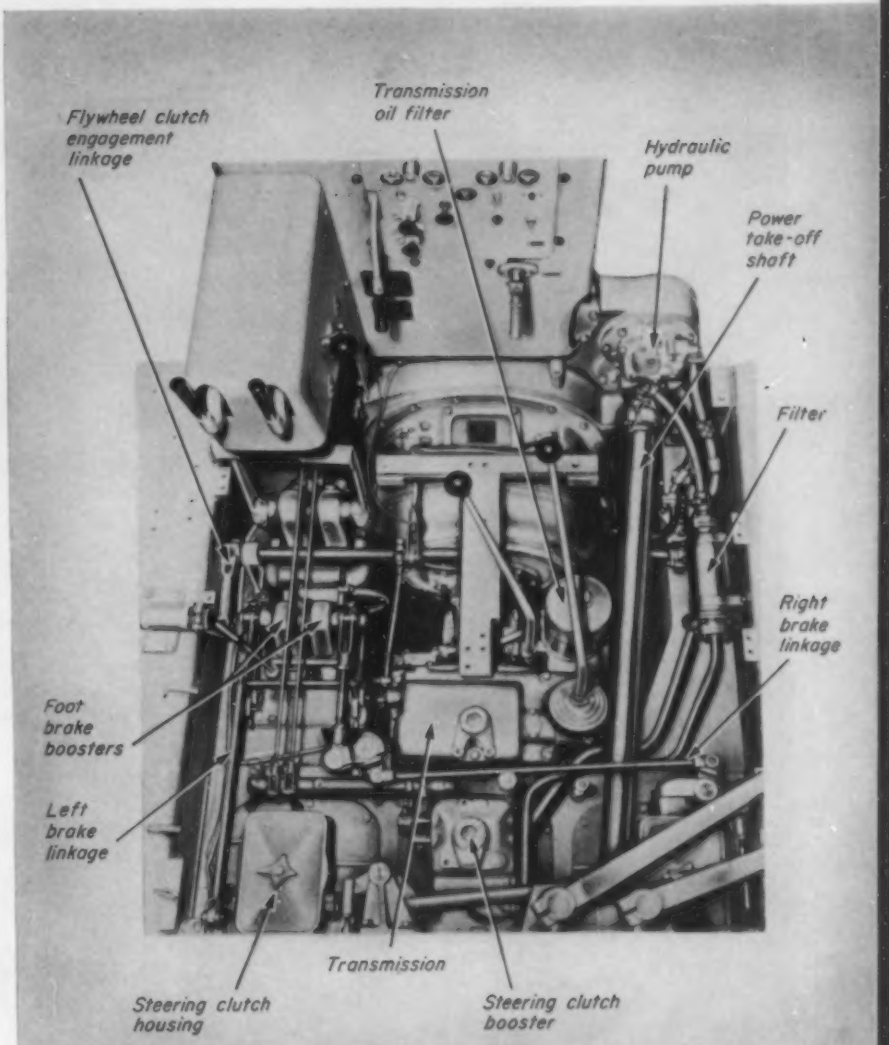
WOOD MOCKUP (above) built in the development stage was an important aid in finding the right position for operator and controls, and also helped in placing major drive components. Suspended brake pedals, designed to keep the deck clear, were discarded later because they required a panel too heavy for easy removal.

Operator position is offset to left with hood cut back on the right and fuel tank curved to give the best combination of forward and rear visibility.

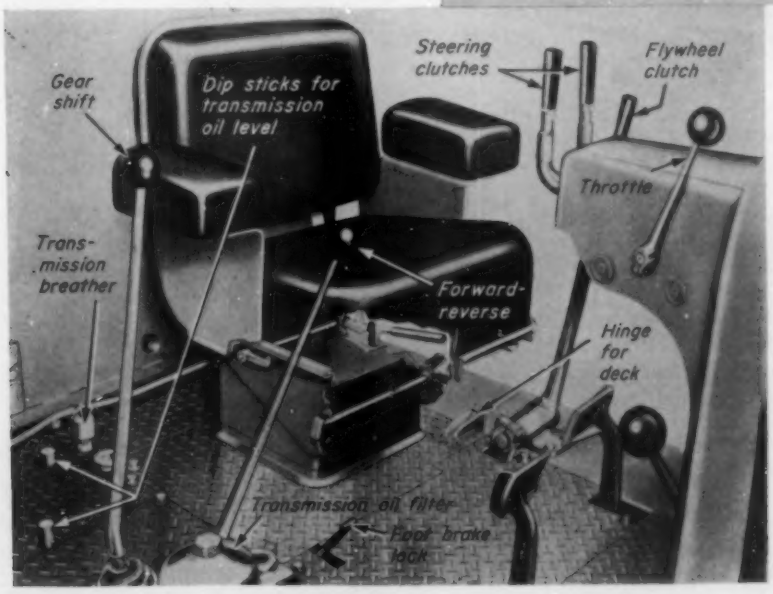
Throttle and steering clutches are directly in front of operator. Flywheel clutch (lever at operator's left) has hydraulically actuated controls; foot brakes, one for each track, have power boosters. On operator's right are the forward-reverse and gear shift levers; above and further right are the control levers required for attachments.



ENGINE STARTING CONTROLS are on the dash within reach of the seated operator. An independent 2-cyl gasoline engine is started by a 6-volt battery starting system. Cooling system of starting engine is integral with diesel engine and thus aids in warm-up. Initial movement of starter gear shift meshes pinion on 2-cyl engine with diesel flywheel; further lever motion engages clutch to rotate diesel.



DECKS REMOVED, right, flywheel clutch, transmission and steering clutches and brakes are all accessible. Hydraulic pump (upper right) driven from the power takeoff shaft supplies booster power for steering clutches and brakes. Note filter in intake line to pump. Transmission is lubricated by full-flow filtered oil with pressure to all bearings and oil spray directed on gears.



Torque converter clutch shown here is an asbestos-faced dry type. Converter uses engine fuel for hydraulic fluid, with a filter and oil cooler mounted on right side of engine.

Operator's seat (left) has a foam rubber cushion, with padded back and arm rests. Seat is adjustable for height, pitch and distance from controls. For easy access to underfloor area, section of deck supporting the seat is hinged and can be swung over the left track to clear the area; seat adjustments are not affected.

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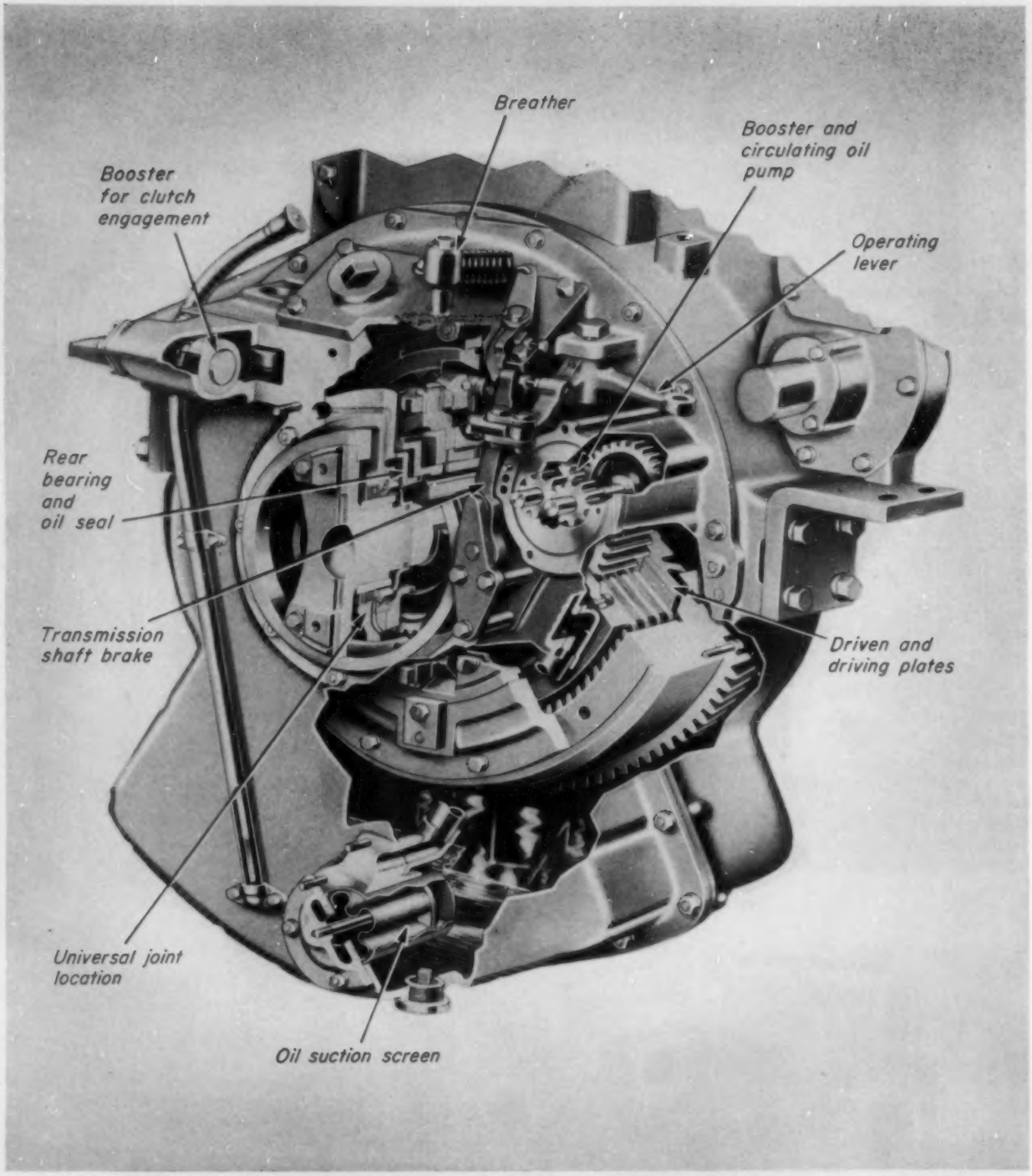
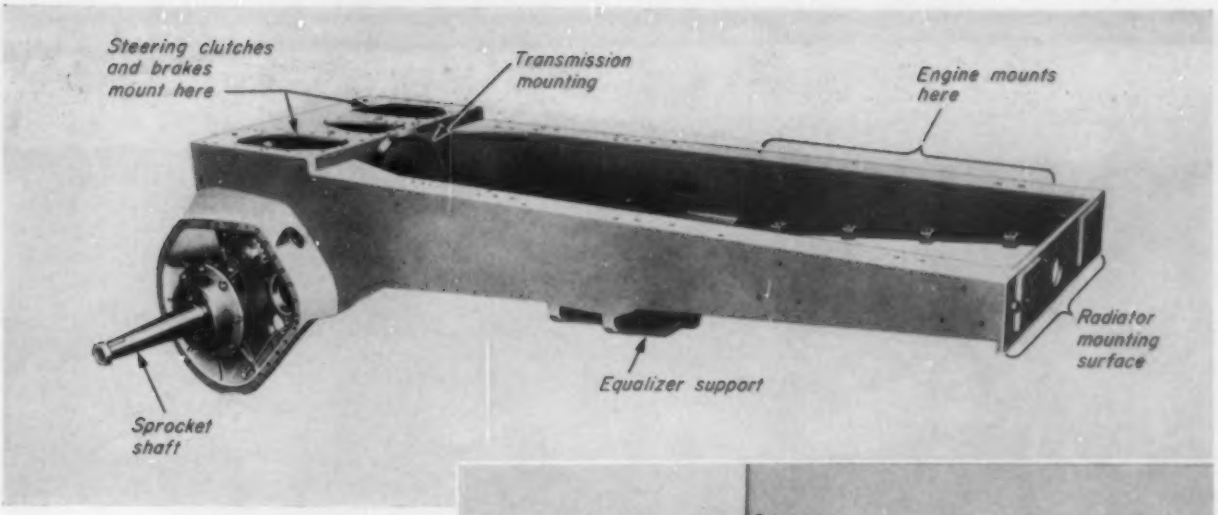


OIL FLYWHEEL CLUTCH in the direct drive has an overhaul period the same as for the engine. Pump within the housing lifts oil from the reservoir through a strainer and forces it through and around the clutch shaft continuously, discharging around the inside diameter of the friction disks. Grooves and slots in the friction faces and pressure plates permit oil flow even when engaged; ejected oil provides continuous lubrication for cams, bearings and internal linkages.

Oil circulation dissipates heat generated in engaging clutch, and reduces wear of facings. Higher engaging forces needed, because of lower coefficient of friction, are provided by booster operated by pressure from the oil pump. A transmission shaft brake, engaged when the clutch is disengaged, aids in rapid gear shifting. Double universal joint between clutch and transmission eliminates need for close alignment and aids in removal of the clutch if necessary for maintenance.

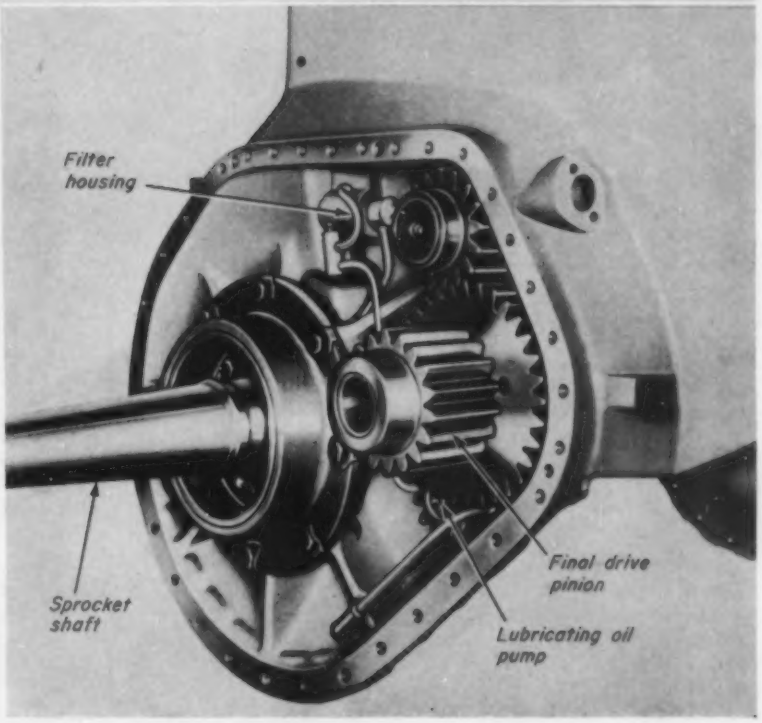
Cooling effect of flow of oil under pressure through slots in the facings is a major factor in reducing wear and distortion of friction faces. Other factors contributing to reduced wear are the completely sealed case which keeps out dirt and water, and the screen in suction line to oil pump. Oil changing is required only at 900-hr service periods.

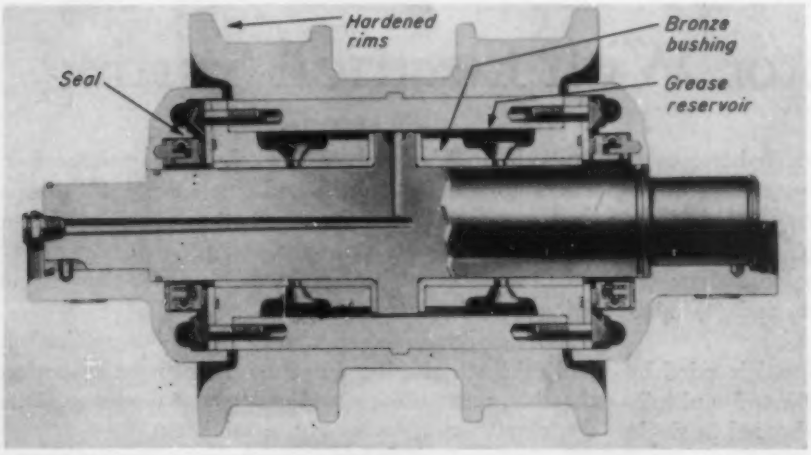


MAIN FRAME is a massive reinforced box section made up of plates, channels and steel castings welded into one rigid structure. Frame is supported by an equalizer bar resting on rubber mounts on each track roller frame.

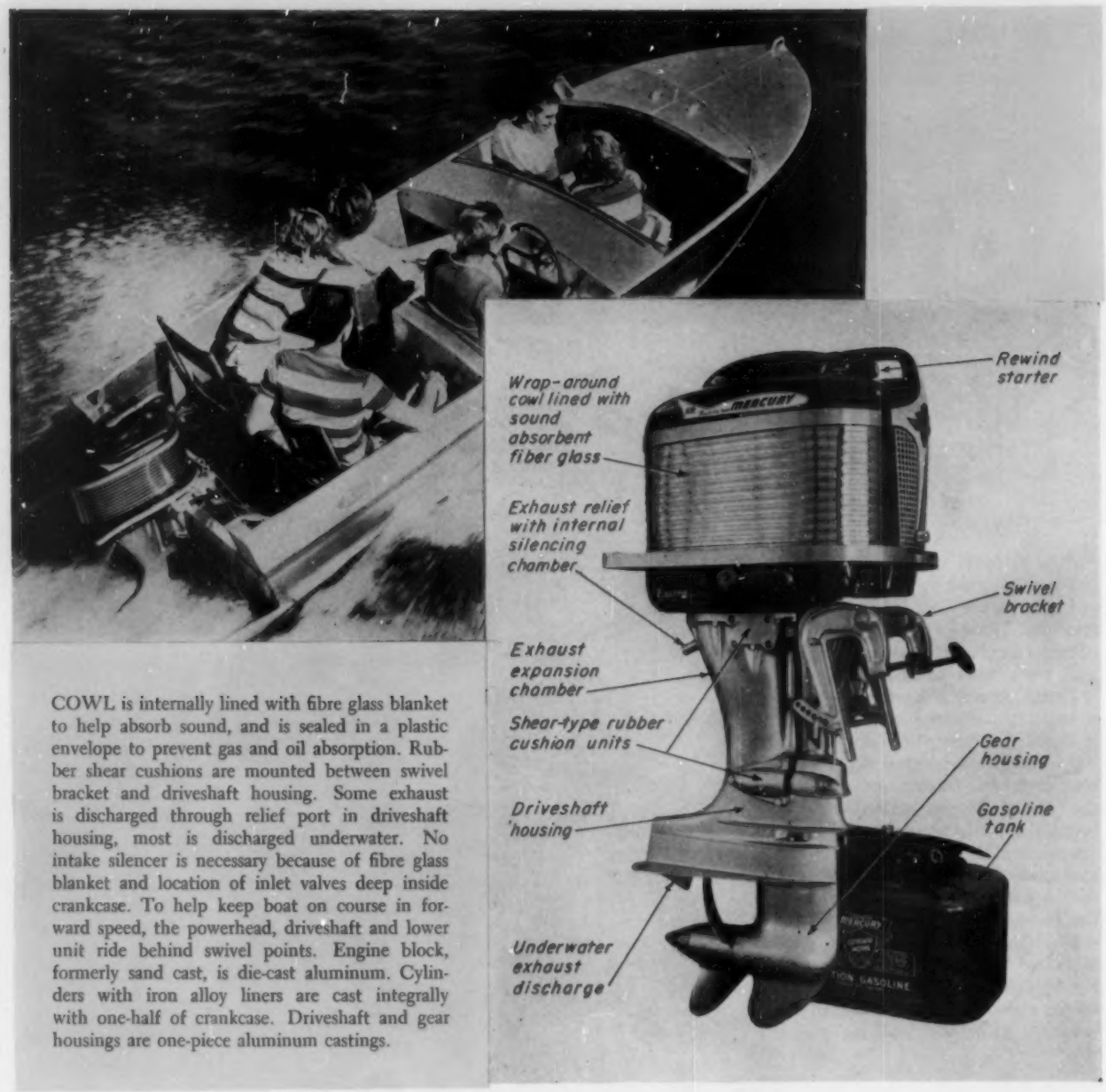
Design permits independent installation or removal of separate assemblies. Engine is mounted at two points at the rear and supported at one point at the front by a cross member. Transmission is bolted to the front of the rear box section; steering clutch and brakes are mounted within the box section. Drive pinion, reduction gear, and sprocket shaft on each side are carried by a steel casting welded integral with the frame.

Final drive on each side is pressure lubricated with a built-in pump geared to the drive. A filter in the delivery side keeps the oil clean. Gears are crown shaved and induction hardened.





TRACK ROLLER presented a difficult problem in lubrication and sealing. Seven are used on each side. Forged steel rims are induction hardened. Bearings are bronze with large thrust area. Each end of roller has heavy spring-loaded pressure seals. Lubricant is forced into bearing from inside, filling a large reservoir.



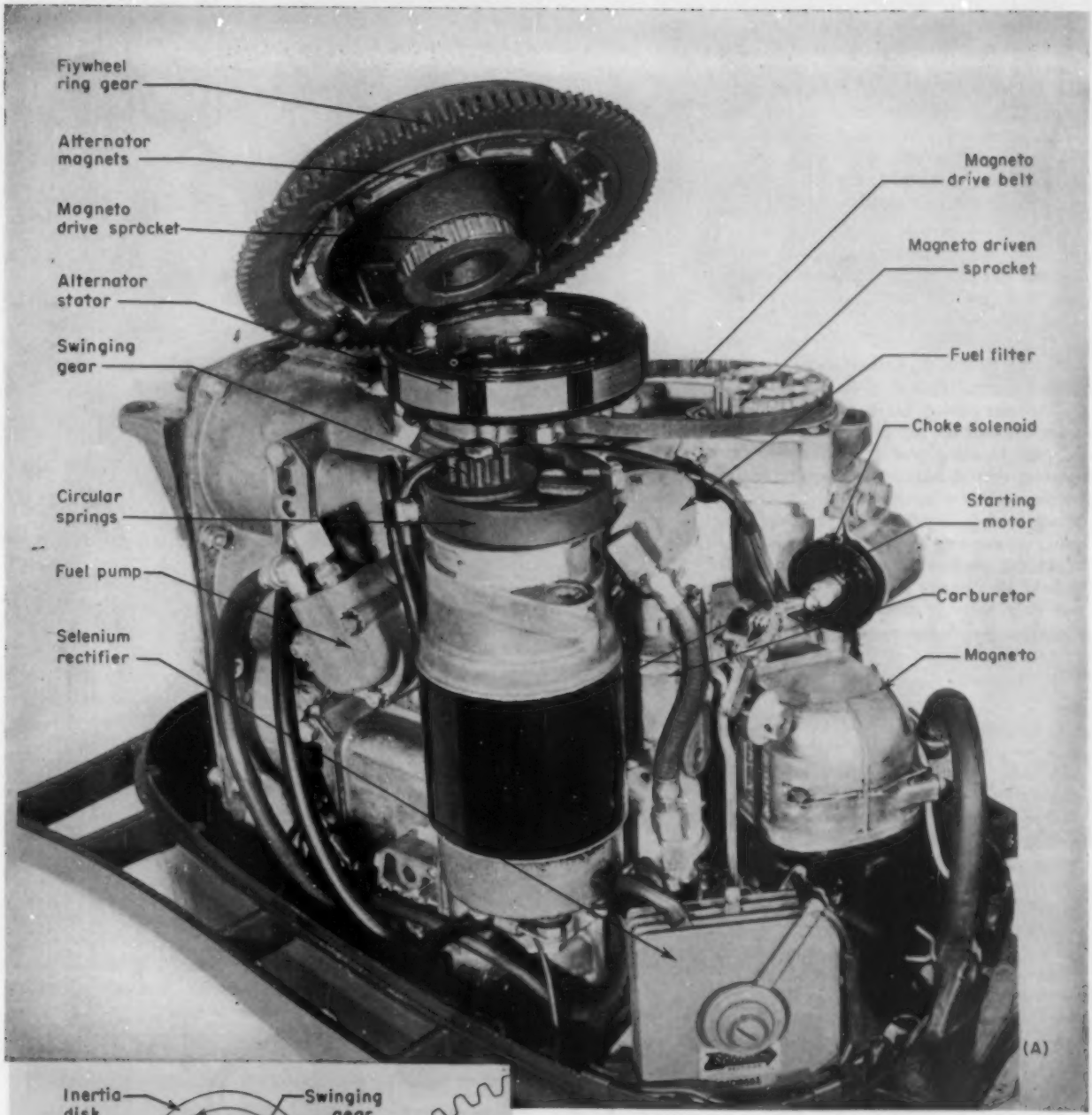
COWL is internally lined with fibre glass blanket to help absorb sound, and is sealed in a plastic envelope to prevent gas and oil absorption. Rubber shear cushions are mounted between swivel bracket and driveshaft housing. Some exhaust is discharged through relief port in driveshaft housing, most is discharged underwater. No intake silencer is necessary because of fibre glass blanket and location of inlet valves deep inside crankcase. To help keep boat on course in forward speed, the powerhead, driveshaft and lower unit ride behind swivel points. Engine block, formerly sand cast, is die-cast aluminum. Cylinders with iron alloy liners are cast integrally with one-half of crankcase. Driveshaft and gear housings are one-piece aluminum castings.

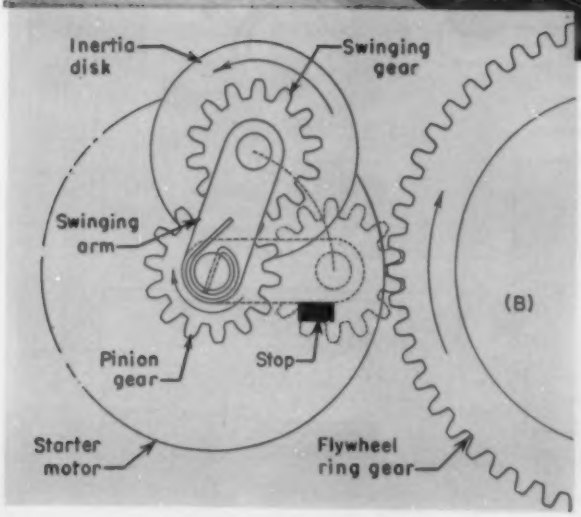
Outboard Motor With Electrical Starting

Problem was to design a compact, high horsepower outboard having automotive control system. Requirements guiding design of the Mercury Mark 55E, manufactured by the Kiekhaefer Corp., Fond du Lac, Wisc., were (1) Internal battery charging system; (2) steady power flow; (3) quiet operation, and (4) minimum weight.

Efficient engine operation at high speed is aided by use of two carburetors, magneto ignition and multiple-reed inlet valves. Remote controls are housed in single unit—the ignition and start switch is key-operated; two levers provide for throttle and gear shift; the choke is push-button operated. Storage battery is charged by an alternator through full-wave rectifier. Steady power flow results from the 2-cycle, 4-cylinder in-line engine firing at 90-deg intervals.

Engine vibration is dampened by rubber cushioning, and exhaust noise is reduced by use of large expansion chamber, relief silencer and underwater discharge. Die-cast aluminum keeps weight to minimum.





(A) The water-cooled 40-hp outboard operates on a 12-volt system. Engine runs on regular automotive gas, and is lubricated by oil in fuel mixture. Battery charging alternator has stator coil secured to top of crankcase; magnets are mounted on inner circumference of flywheel. As alternator has no brushes or slip rings, unit is adaptable to high rpm operation with no possibility of arcing or sparking. Magneto for the ignition is a stationary-coil, rotary-magnet unit driven from the crankshaft by a flexible timing belt. Magneto can be serviced by removing screws and lifting head. Spark is automatically synchronized with throttle opening by a lever on the magneto actuating a throttle pick-up arm. Magneto is internally vented by two flexible tubes.

The shift and speed levers interlock to prevent shifting at high engine speed and to limit speed in neutral or reverse gear. A diaphragm fuel pump actuated by pulsations in crankcase

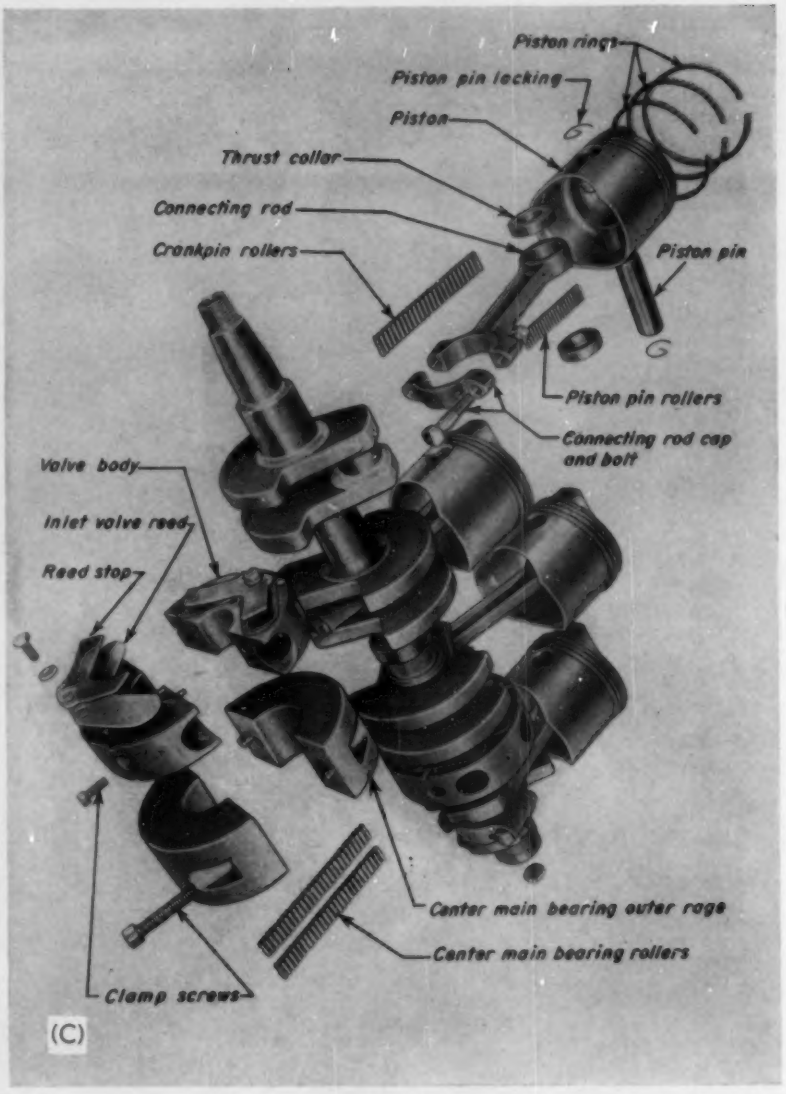
pressure eliminates the usual pressurized fuel tank and makes possible a single fuel line. A porous metal fuel filter is placed at the top of each of the two straight-tube carburetors mounted on the crankcase. Starter motor is fully enclosed two-pole series wound; the swinging gear mounted on an arm at the drive end of the motor and aided by a circular spring drives the flywheel ring gear until engine exceeds cranking speed.

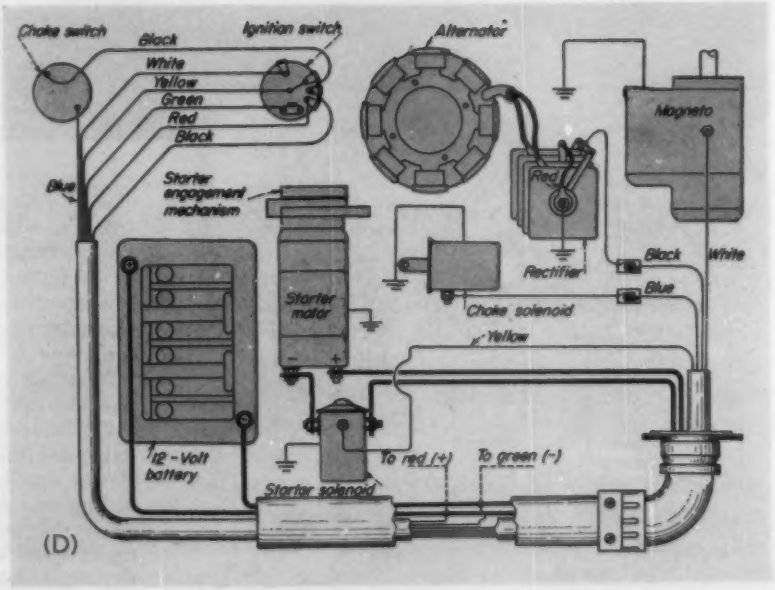
(B) When starting motor is energized, inertia disk and spring delay the rotation of swinging arm until starting motor and drive have stored sufficient energy to accelerate the engine to cranking speed. Then swinging gear is rotated to engage flywheel gear. Engagement is limited by a stop on the end of a stiff circular spring (as seen in A). This spring cushions the swinging arm and permits the gear to swing past center to disengage the ring gear should engine backfire. After engine accelerates beyond cranking speed and driving load is transferred to the ring gear, spring on swinging arm returns swinging gear to starting position. Should ignition switch be held after engine is started, the swinging gear only spins in disengaged position; to re-engage, the motor must decelerate until inertia disk is again ready to accelerate the swinging arm.

(C) Crankshaft is supported by five main bearings—a center journal, a ball bearing at each end, and at intermediate points by the inlet valve bodies. The center bearing and the two valve bodies separate crankcase chambers; split for installation on crankshaft, each unit is aligned by dowel pins and secured by clamp screws. The spring steel reeds on the valves are actuated by crankcase pressure pulsations; thus, timing and degree of valve opening automatically adjust to engine speed. When engine is not running, reeds seat in closed position, effectively sealing the crankcase. Stop plates are curved to control degree and form of reed deflection.

Connecting rods ride wrist pins and crank pins on roller bearings; rods and caps are doweled by bolts. Steel collars on piston pins between rods and pin bosses restrict side motion of rods so lower ends ride between crank cheeks with ample clearance. Pistons are made of aluminum forgings, favored over castings for grain structure strength and density. To guard against piston rings engaging edges of port holes, rings are positioned by pins in ring grooves. Piston pins are secured in bosses by expanding wire lock rings.

(D) Turning ignition key to "start" position energizes solenoid starting switch to connect battery across starter motor. Solenoid on choke control makes possible remote operation. Alternator and rectifier combination was selected in preference to d-c generator, to avoid brush problems of fire hazard and wear.





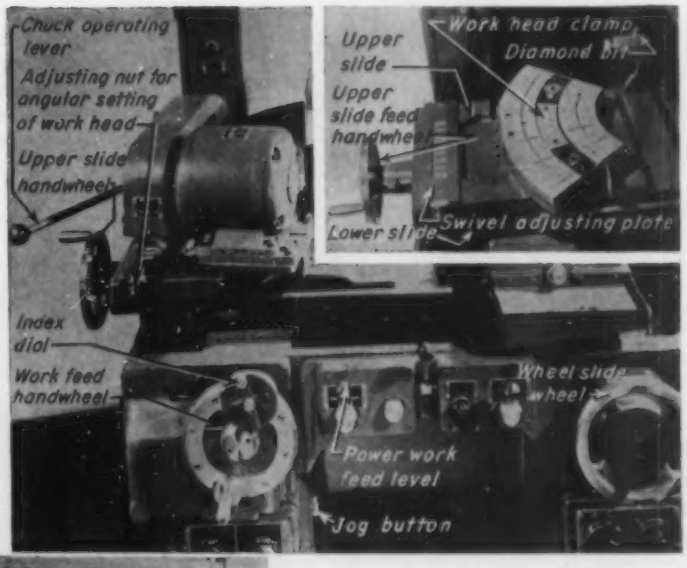
Re-Engineered Face Grinder

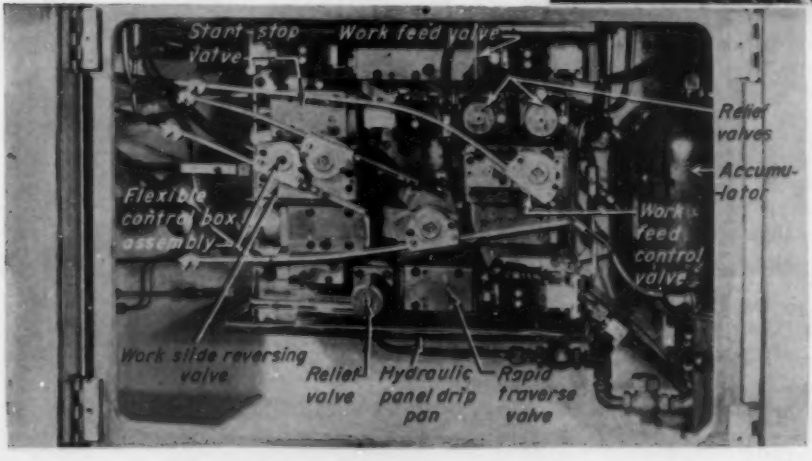
To improve operator convenience was basic aim in the redesign of the No. 11 Face Grinder by Brown & Sharpe, Providence, R. I. Major requirements were (1) Work holder to be lever operated, and loaded from front of machine; (2) work to be angularly adjustable; and (3) work slide to permit set diamond wheel dressing. First requirement was met by horizontal work spindle axis parallel to front of machine; second by manually controlled swivel mounting; third by compound slide. Vertical work mounting facilitates coolant flushing chips.

HOLDING POWER of permanent magnet chuck is controlled by lever conveniently placed at operator's left; right hand is free to position work on chuck. Work head is driven by a constant speed a-c motor and V-belt with three step pulleys.

WORK HEAD and drive are mounted on a compound slide. Lower slide, operated by front handwheel through bevel gearing, supports both diamond dresser and upper slide. Handwheel at left side operates upper slide through a lead screw engaging a nut to position work relative to diamond dresser during setup. To angularly adjust work head, nut is rotated on threaded stud, sliding a slotted swivel plate; work head is guided by rollers in circular groove. Center of arc is approximately 1 in. in front of chuck face, to minimize axial displacement of work to wheel.

A vane-type ball bearing hydraulic motor was developed for power in-feed giving 0.0001 in. feed for 6 deg rotation of the motor. Wheel slide controls are in a side compartment and cam operated; dogs on wheel slide were avoided to eliminate inaccuracy caused by gradual slide displacement. Wheel reversing valves are cammed directly for cushioning action; stop and fast travel valves are solenoid actuated.

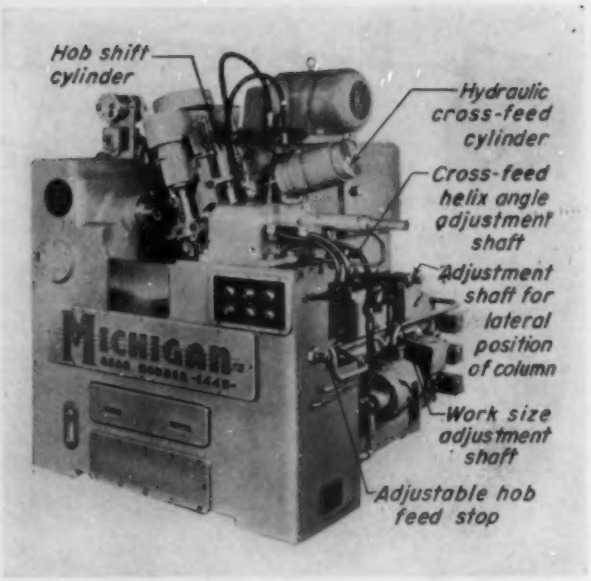




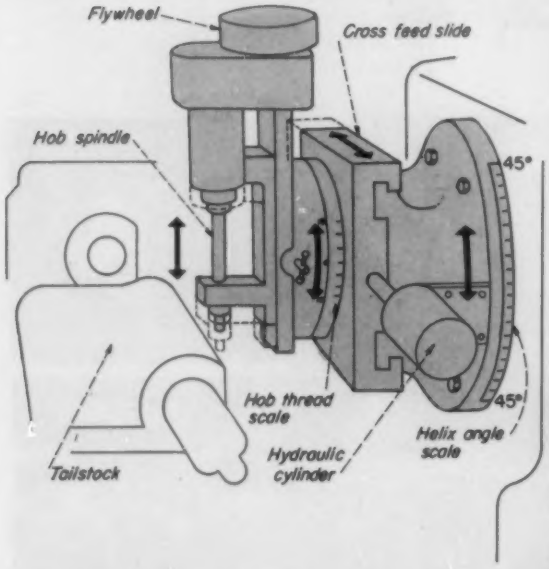
MANUALLY OPERATED hydraulic valves are dial controlled through flexible shafting to bring them together on an accessible hydraulic panel. Valves are flange-mounted for removal without disturbing piping. Accumulator is used to supply power for rapid retraction of cross feed.

Angularly Adjustable Hob Head

Problem was to incorporate two angular adjustments –for gear helix and hob thread–in addition to two sliding motions–horizontal cross feed and vertical hob shift–into head of hobbing machine. Reason for design was to eliminate need of extra change gears in helical gear hobbing setup. All requirements were met and positive hob spindle drive maintained by gearing arrangement in 4-section head developed by Michigan Tool Co., Detroit, in the Model 1445 Gear Hobber.

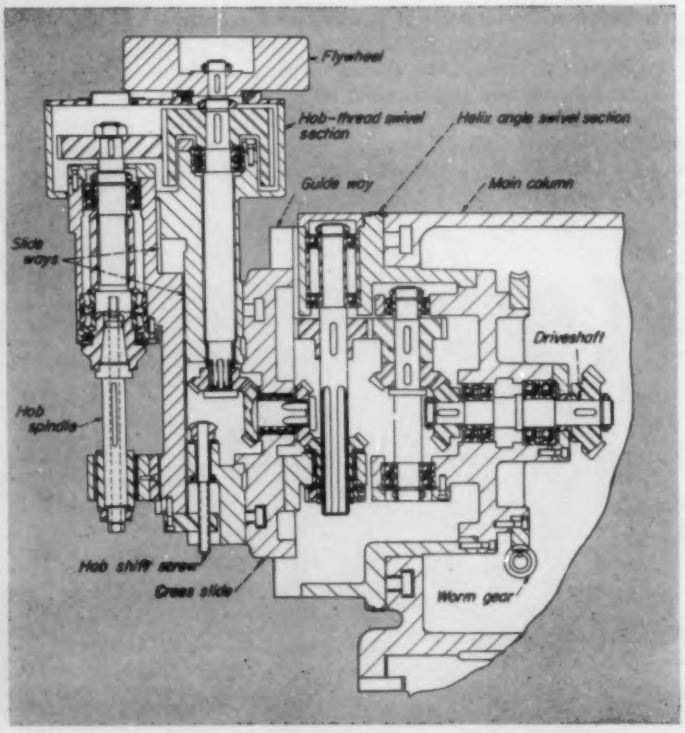


(ABOVE) MAIN COLUMN moves forward, plunge feeding hob to gear tooth depth; then cross slide feeds hob transversely across work piece at helix angle of gear. Major initial set-up adjustments are made from right side of machine; all are screw-type. Hob spindle is set at proper angle of cut after loosening bolts in swivel plate. Pitch diameter of gear being cut is controlled by shaft that adjusts position of hob spindle with respect to work, and by hydraulically-actuated Z-bar stop for infeed and return. Hob can be shifted to new cutting position by manual push-button operation or automatically at end of hobbing cycle; shift is effected by hydraulically actuated pinion-rack which through ratchet wheel drives screw attached to hob spindle housing. Feed rates for plunge and transverse feeds are infinitely variable, adjusted on hydraulic flow control valves.



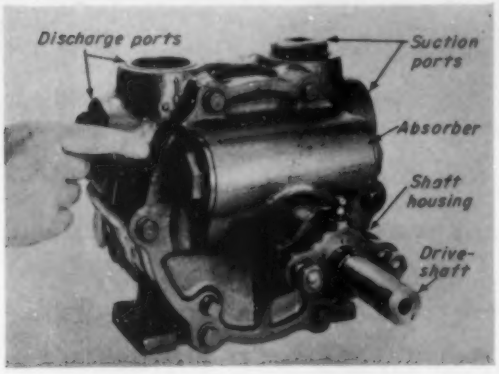
Four-section head (above) has two swivel and two slide motions as indicated. Helix-angle swivel section has scale for adjusting spindle up to 45 deg cut left or right hand. Scale on hob thread swivel allows for variable thread of 14 deg left or right hand; thread swivel is manually screw-positioned after loosening four bolts. Flywheel damps out torsional vibrations in drive system.

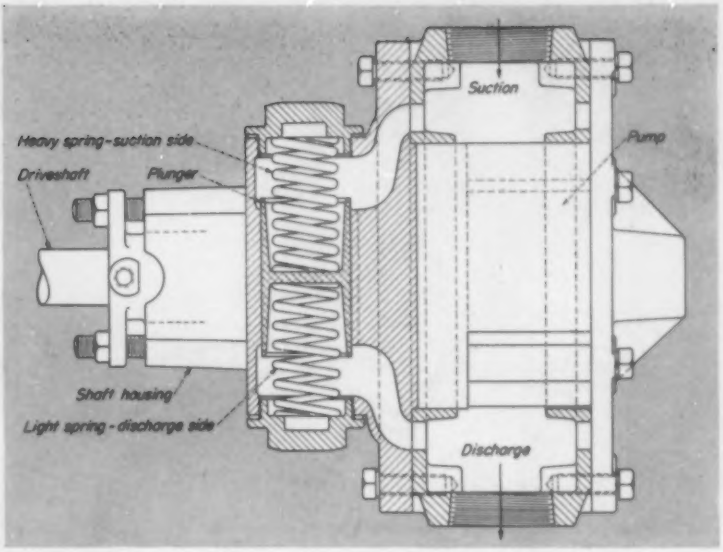
HELIX-ANGLE SWIVEL SECTION rotates about driveshaft by worm gear, and is guided by studs sliding in circular T-groove. Bevel gears provide 90 deg shift of drive-shaft axis, with spur gears transmitting drive to splined shaft in swivel section. Second set of bevel gears ride in splined shaft allowing cross-slide travel. Hob-thread swivel, guided by studs in circular T-groove in cross-slide, rotates about its driveshaft axis, with bevel gears again shifting axis of drive. Drive is then transmitted to hob spindle through spur gears; hob-spindle section slides on wide-face spur gear and ways.



Spring-Action Pulsation Absorber

Built-in pulsation dampener unit, using spring-loaded piston, has been developed by Yale & Towne Mfg. Co., Stamford, Conn., and incorporated into the Tri-Rotor Pump. The dampener requires no changes in capacity or basic action of pump, and absorbs pressure peaks up to 125 psi.

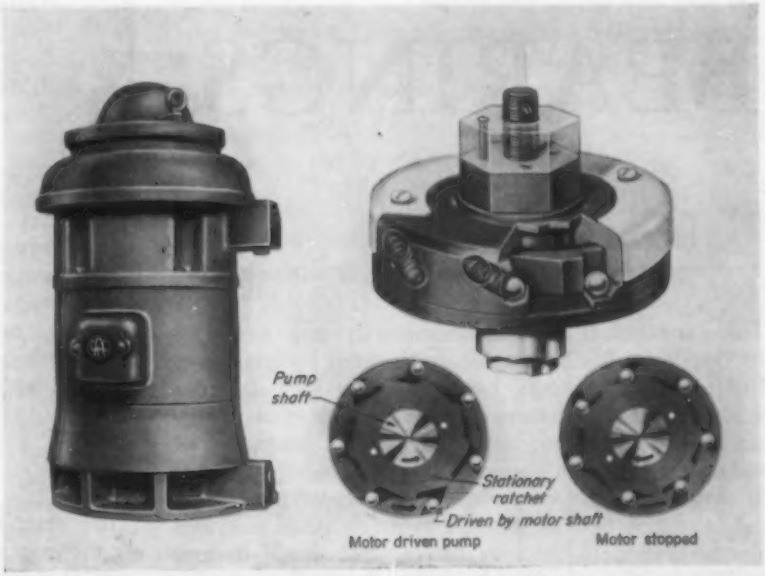




CYLINDRICAL DAMPENER UNIT (left) is designed as part of a new shaft housing which can replace the conventional housing without disturbing piping. Both springs, as shown above, are assembled with initial compression; plunger is at center under normal conditions. Spring on discharge side keeps plunger against heavier spring on suction side. A back pressure in the discharge line will force plunger towards suction side, forcing some fluid into suction zone of pump. Counter force exerted by heavy spring dampens plunger motion, and fluid that entered discharge side of absorber cylinder returns to discharge line. Should pressure surge occur in suction line, light spring on discharge side of plunger dampens plunger motion.

Centrifugal Ratchet

For quick positive lock against pump motor backspin, this vertical hollow shaft pump, supplied by ACEC Electric Corp., New York City, has a ball ratchet mounted just above the motor. When pump stops, water column on discharge side tends to run back through the pump, reversing rotation; excessive shaft speed can result, damaging bearings. Earlier solutions included a pin ratchet which was subject to shear, and later a spring coupling which tended to lose tension with age. This new ball ratchet locks against reverse spin within 5 deg rotation after shaft reversal begins.



RATCHET ELEMENT is stationary; outer member and balls rotate with motor shaft. When motor drives the pump, steel balls are lifted clear of ratchet into slots by centrifugal force. As motor coasts to a stop, balls roll down slots and come to rest against the stationary ratchet. When pump shaft stops and starts to reverse, one of the balls engages the ratchet. Combination of 7 balls and 9 ratchet teeth assures that pump shaft will be locked with no more than 5 deg reverse rotation.

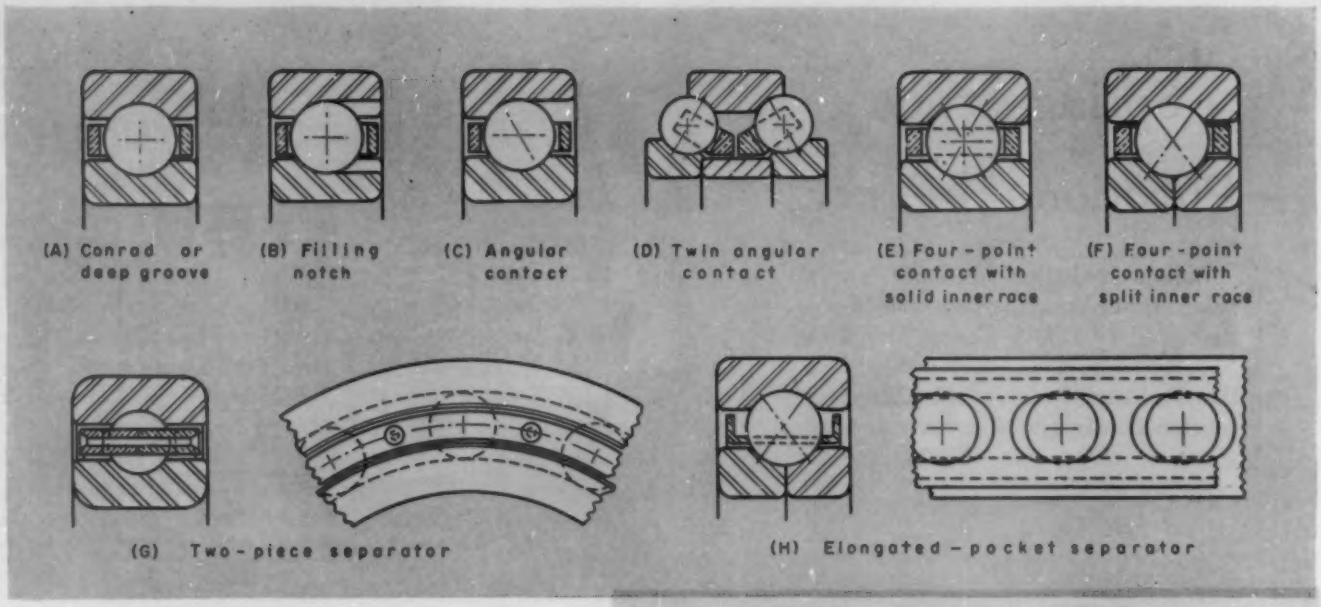

(A) Conrad or deep groove
(B) Filling notch
(C) Angular contact
(D) Twin angular contact
(E) Four-point contact with solid inner race
(F) Four-point contact with split inner race
(G) Two-piece separator
(H) Elongated-pocket separator

FIG. 1—Basic types of large diameter radial ball

LARGE BALL BEARINGS

Basic types in sizes of 6-in. bore and over; races and separators available; effect of speed, and number and size of balls on capacity; selection of bearing material and tolerances.

LLOYD JONES, JR.
Chief Bearing Engineer, Kaydon Engineering Corporation

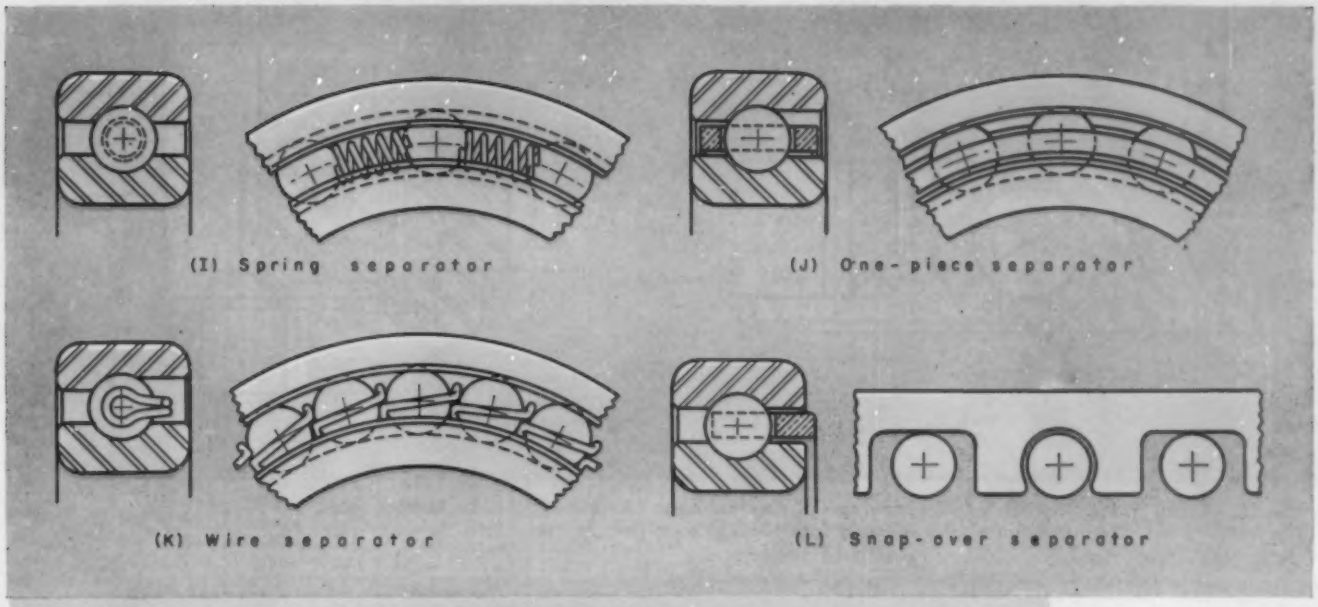
THE PROBLEM of rotating large masses with minimum friction losses has been successfully solved by using large ball bearings. However, bearings with a bore size over 6 in. are unavailable except on special order even though sizes up to 20-in. bore are listed in some catalogs. The wide range of sizes in demand (up to 10 ft in bore diameter in some military applications) and the numerous increments of size that are possible over this range precludes standardization in the near future. But special features such as built-in mounting holes and flanges that simplify assembly problems can be incorporated in made-to-order bearings.

Trend in large bearings is to specify the pitch diameter instead of the inside or outside diameters and thus allow the manufacturer to choose a cross-section based on the performance requirements. Usually the over-all dimensions and ball sizes of a large bearing are not in proportion to a standard small bearing because of weight and cost considerations. As an example, a standard small bearing of the extra-light series with a 5-in. pitch dia has a 1-in. width and ½-in. dia balls. A large bearing with a pitch dia ten times larger or 50 in. has a width of only 4 in. (instead of 10 in.) and 2-in. balls (instead of 5 in.).

BASIC TYPES

Important factors influencing the capacity of a bearing are the number of balls, conformity of ball path and the angle of contact between a ball and its race. These factors vary with basic type of cross section.

The Conrad ball bearing, Fig. 1(A), is is loaded by eccentric displacement of the race so that slightly more than one-half a full complement of balls can be assembled. This permits the use of uninterrupted deep-groove races with



bearings and separators. Thrust bearings are shown in Fig. 3

20 to 25 per cent lip height and is suitable for radial loading or moderate thrust loading.

Various cages or separators can be used to space the balls equally and insure proper load distribution. When speed of rotation is low, the separator can be made in sections, Fig. 1(G), in this manner saving weight and cost.

Where moment loads are comparatively heavy, the stamped cage with elongated pockets (H) or individual springs between balls (I) is used. These reduce the rotating resistance of the bearing by permitting the balls to relocate while passing from the load zone to the free zone without interfering with other balls. These separators are light and can be treated for corrosion resistance if so desired.

Filling-notch type of ball bearing (B) has a loading notch in each race and can contain a full complement of balls; however, space is usually allowed for a separator. Since it contains more balls than the Conrad bearing, its radial capacity is greater. It is rarely used in thrust or high moment loading unless the notches can be kept apart as when used in gun turrets that have restricted arcs of travel.

Angular-contact radial bearing (C) is generally used in pairs or in spread mountings. The counterbore in the outer race permits more balls to be assembled than in the Conrad bearing. Both the radial and thrust capacities are greater than the Conrad type, but a high radial load would nullify the angle of contact and reduce the trust capacity unless it is rigidly opposed. The bearing can be designed for contact angles up to 30 deg and, in most instances, is assembled with either a one-piece separator (J) or a wire separator (K).

When the angular contact bearings are used in pairs and where weight is an important factor the inner or outer races of the two bearings can be combined into one piece as shown in (D). The separator generally used is either the wire (K) or the snap-over (L).

A popular type of large ball bearing is the four-point contact type which can carry any combination of high thrust, radial or moment loads. It is designed with both races solid (E) or either race split (F); the latter permitting a larger complement of balls. The grooves are ground with a special contour so that balls contact the grooves at only four points. By increasing the angle of contact, up to 35 deg for the solid race and 45 deg for the split race, the thrust and moment capacities are increased. These bearings can replace duplex pairs of angular contact bearings with savings in both cost and weight.

Table I—Average Life Factors
based on 3000 hours = 1.000

HR	FACTORS	HR	FACTORS	FACTORS	HR
600	0.585	7000	1.326	0.6	650
800	0.643	8000	1.387	0.7	1030
1000	0.693	9000	1.442	0.8	1540
1200	0.737	10000	1.494	0.9	2190
1400	0.775	12000	1.587	1.0	3000
1600	.811	14000	1.671	1.2	5180
1800	.843	16000	1.747	1.4	8230
2000	.873	18000	1.817	1.6	12290
2200	.902	20000	1.882	1.8	17500
2400	.928	25000	2.026	2.0	24000
2600	.953	30000	2.154	2.2	31900
2800	.977	35000	2.268	2.4	41500
3000	1.000	40000	2.371	2.6	52700
3200	1.022	50000	2.554	2.8	65900
3400	1.043	60000	2.714	3.0	81000
3600	1.063	80000	2.987	3.2	98300
3800	1.082	100000	3.218	3.4	117900
4000	1.101	140000	3.600	3.6	140000
5000	1.185	180000	3.915	3.8	164600
6000	1.256	200000	4.055	4.0	192000

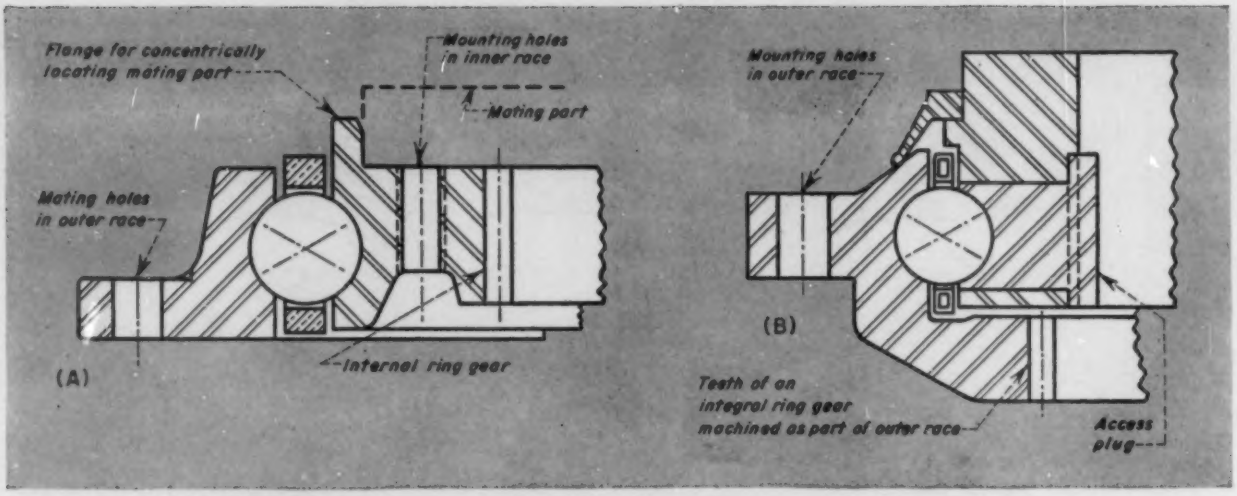

Flange for concentrically locating mating part
Mounting holes in inner race
Mating part
Mating holes in outer race
(A)
Internal ring gear
Mounting holes in outer race
(B)
Teeth of an integral ring gear machined as part of outer race
Access plug

Fig. 2—Ball bearings with special cross-sections: (A) mounting holes in both races, (B) mounting holes in outer race; filling notch for inserting balls in inner race.

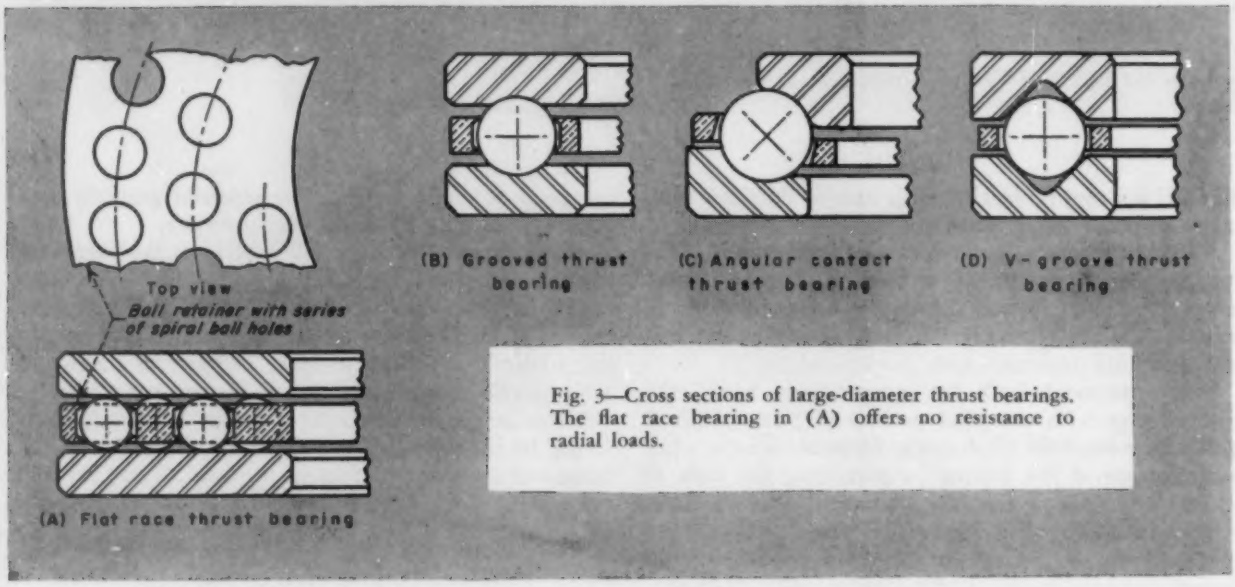

Top view
Ball retainer with series of spiral ball holes
(A) Flat race thrust bearing
(B) Grooved thrust bearing
(C) Angular contact thrust bearing
(D) V-groove thrust bearing

Fig. 3—Cross sections of large-diameter thrust bearings. The flat race bearing in (A) offers no resistance to radial loads.

SPECIAL SECTIONS

Since the races on large bearings are made to order they can be designed as part of a major component such as a ring gear or with bolt holes for fastening as shown in Fig. 2(A). Surfaces can be extended to support shields or seals that protect races from contamination.

For applications having a limited arc of travel, an access plug, Fig. 2(B), located out of the zone of ball pressure, can be used to increase the number of balls in a bearing. This also permits a larger lip height and thus a greater contact angle.

THRUST BEARINGS

The thrust bearing with flat races shown in Fig. 3(A) has a ball cage with a series of spirals so that a multiplicity of ball paths results. The large number of balls gives this type of bearing a fair radial capacity in addition to its thrust capacity and is commonly used in indexing tables. Since it does not have any resistance to radial loads, radial location of the races within close limits is unnecessary. An inherent disadvantage is the slippage that occurs because the balls roll on tracks of various radii.

Grooved thrust bearing (B) has a greater thrust capacity than the flat race type but requires an additional bearing to take radial loads. This problem is reduced in the angular contact thrust bearing (C) which is designed with contact angles up to 60 deg to resist radial loads of fair magnitude in relation to the applied thrust loads. Since they are primarily thrust bearings there is no resistance to radial loads without application of a thrust load. In such cases where the radial load is of high magnitude a "hold down" bearing must be used to prevent axial separation of the races.

The V-groove thrust bearing (D) is a rarity in large bearings but is used in applications where positive centering is required and radial loads are light.

Table II—Speed Factors
based on 100 R.P.M. = 1.000

RPM	Factor	RPM	Factor	RPM	Factor	RPM	Factor
10	2.000	440	0.610	1150	0.443	3900	0.295
20	1.710	460	0.601	1200	0.437	4000	0.292
30	1.494	480	0.593	1250	0.431	4200	0.288
40	1.357	500	0.585	1300	0.425	4400	0.283
50	1.260	520	0.577	1350	0.420	4600	0.279
60	1.186	540	0.570	1400	0.415	4800	0.275
70	1.126	560	0.563	1450	0.410	5000	0.271
80	1.077	580	0.557	1500	0.405	5500	0.263
90	1.036	600	0.550	1600	0.397	6000	0.255
100	1.000	620	0.544	1700	0.389	6500	0.249
110	0.969	640	0.539	1800	0.382	7000	0.243
120	0.941	660	0.533	1900	0.375	7500	0.237
130	0.916	680	0.528	2000	0.368	8000	0.232
140	0.894	700	0.523	2100	0.362	8500	0.227
150	0.874	720	0.518	2200	0.357	9000	0.223
160	0.855	740	0.513	2300	0.352	9500	0.219
170	0.838	760	0.509	2400	0.347	10000	0.215
180	0.822	780	0.504	2500	0.342	11000	0.209
190	0.807	800	0.500	2600	0.338	12000	0.203
200	0.794	820	0.496	2700	0.333	13000	0.197
220	0.769	840	0.492	2800	0.329	14000	0.193
240	0.747	860	0.488	2900	0.325	15000	0.188
260	0.727	880	0.484	3000	0.322	16000	0.184
280	0.709	900	0.481	3100	0.318	17000	0.181
300	0.693	920	0.477	3200	0.315	18000	0.177
320	0.679	940	0.474	3300	0.312	19000	0.174
340	0.665	960	0.471	3400	0.309	20000	0.171
360	0.652	980	0.467	3500	0.306	25000	0.159
380	0.641	1000	0.464	3600	0.303	30000	0.149
400	0.630	1050	0.457	3700	0.300	40000	0.136
420	0.620	1100	0.450	3800	0.297	50000	0.126

BEARING MATERIALS

The bearing races are usually made from steel forgings, although some resistance welded rings are occasionally used. In sizes to 4 ft in diameter either hammered forgings or rings rolled on a tire mill are equally suitable. Both produce continuous rings without seams or joints, the rolled rings being considerably cheaper if produced in volume. When the diameter is over 4 ft the rolled rings predominate, even if ordered in single units, because of handling difficulty in a forging hammer or press.

The selection of material depends upon many factors, including service requirements, special design requirements and manufacturing feasibility. Usually one of the high carbon high chromium bearing steels, such as SAE 52100 is used for bearings of conventional design. If the volume justifies the initial cost, considerable economies can be attained by using special quenching fixtures. In some instances, these fixtures are required for even single units to produce thin section bearings.

In bearings with special features, steels of medium carbon content are employed, such as SAE 4140, 4150, 1065, and 8660. These materials are heat treated (quenched and tempered) as forgings, prior to machining, to develop optimum core properties for good machinability, response to flame hardening, dimensional stability and low temperature impact strength.

The paths require a hardness about Rockwell C 60, but the adjacent areas often must be soft enough, about Rockwell C 30, to be easily machined for gear cutting, drilling and tapping. In the past, this was done by selective carburizing, which is still sometimes practiced in sizes under 36 in. diameters. The heat-treating problems, however, become severe when this method is applied to the complicated large-diameter thin-section bearings. The development of precision deep flame hardening has overcome this difficulty and where production volume is high, the induction hardening method has also been used.

For corrosion resistance, any of the standard protective coatings can be used; black oxide, phosphate, cadmium and chromium plating are the most common. Alloys such as the 400 series stainless steel or K and S Monel metals are used for extreme corrosive conditions.

TOLERANCES

The accuracy of large-diameter ball bearings is above average when compared with the smaller bearings. Eccentricities of 0.001 and 0.002 in. are commonplace in large bearings and by comparison in size would be equivalent to *ABEC* 5, 7 or 9. Tolerances on diameters, face runout or groove parallelism with the faces can be held to 0.002 in. or less.

Accuracy of drilled holes for mounting purposes is high in special bearings produced in quantity since precision drill jigs or templates are frequently used. For pilot or prototype models the general procedure is to lay out the holes to reasonably close limits in the bearings and then transfer the hole locations to the mating parts.

Bearings with precision gears machined as part of the races are prepared with ground pilots for plug mounting on gear cutting machines. This achieves a higher concentricity between bearing and gear than can be obtained by separate assembled components.

BEARING DESIGN

Large bearings are not stocked items and often take considerable time to design and produce. Full use of the bearing manufacturer's engineering and manufacturing experience should be made to obtain the optimum bearing for a particular application. A sketch of the application and complete data of the operating conditions should be submitted with an inquiry such as: applied loads, speed, desired life expectancy, shock and vibration conditions, intended lubrication, shaft fits, desired protective coating and required accuracies.

One of the most important factors influencing the load capacity of a particular size bearing is the number and size of balls to be used. As an example, for a Conrad type bearing with a 50 in. pitch dia, the variations in ball size will result in the following load capacities, based on an average stress of 400,000 lb/in.^{2} of ball contact area (path conformity 53 per cent of ball dia):

Ball Size, in.	No. of Balls	Radial Capacity, lb. 3,000 hr life at 100 rpm	Static Capacity, lb.
½	158	14,500	90,000
1	80	37,000	180,000
1½	53	63,500	270,000
2	40	93,500	360,000

Not only does a reduction in ball size decrease the radial load capacity, but the resultant increase in number of balls increases the friction torque of the bearing.

For a preliminary design, the size and number of balls required can be obtained by the following formulas:

$$C = \frac{P \times F}{S} \quad (1)$$

where

P = load on bearing at operating speed, lb
F = life factor desired (based on 3,000 hr life, see Table I)
S = speed factor (based on 100 rpm, see Table II)
C = converted load rating, lb (3000 hr life at 100 rpm)

If both radial R and thrust loads T are present, the load P becomes an "equivalent radial load" (E_r) if the radial load predominates, and "equivalent thrust load" (E_t) if the thrust load predominates. Moment loads are resolved into radial and thrust loads. Equivalent loads vary with type of bearing as follows:

Conrad Bearing,

$$E_r = R + 1.5T \quad (2)$$

Angular Contact Radial Bearing (for 30 deg contact angle),

$$E_r = R + T/3 \quad (3)$$

$$E_t = R + 3R \quad (4)$$

Angular Contact Thrust Bearing (for 60 deg contact angle),

$$E_r = T + 3R \quad (5)$$

The number and diameter of balls influence the load rating C of the bearing as shown in the following table:

RADIAL BEARINGS		
Conrad, Fig. 1(A)	$C = 2{,}000A\,N^{2/3}D^2$	(6)
Angular Contact, Fig. 1(C)	$C = 2{,}000A\,N^{2/3}D^2 \cos\alpha$	(7)
THRUST BEARINGS		
Flat Race, Fig. 3(A)	$C = 2{,}000\,N^{2/3}D^2$	(8)
Grooved, Fig. 3(B)	$C = 6{,}000\,N^{2/3}D^2$	(9)
Angular Contact, Fig. 3(C)	$C = 6{,}000\,N^{2/3}D^2 \cos\alpha$	(10)

where:

A = number of rows of balls
N = number of balls per row
D = diameter of balls, in.
α = contact angle

Thus, for a Conrad type bearing, Eq (1), based on the external factors that influence a bearing and Eq (6), based on the internal factors, can be combined as follows:

$$\frac{P \times F}{S} = 2{,}000A\,N^{2/3}D^2 \quad (11)$$

Static (non-brinell) bearing capacities are higher than the dynamic capacities and are used as a check against damage of the races. They are based on an average stress of 400,000 lb/in.^{2} of contact area which is the maximum loading permissible without permanent deformation. The equations for determining the static capacity SC of a bearing are as follows:

Conrad	$SC = 2{,}280\,AND^2$
Angular, Fig. 1(C)	$SC = 2{,}280\,ND^2\cos\alpha$
Flat race	$SC = 1{,}000\,ND^2$
Grooved	$SC = 11{,}400\,ND^2$
Angular, Fig. 3(C)	$SC = 11{,}400\,ND^2\cos\alpha$

The average life expectancy is based on the average life of a group of 50 or more bearings. A bearing in this group may have a minimum life of 1/5 the value of the average.

Indexing Sources of Information

A SERVICE that will provide government agencies with a more complete access to information on measuring instruments, controls, and data handling devices, uses an improved system for indexing sources of information. Developed by the National Bureau of Standards, the system requires inexpensive hand-operated indexing equipment. Based on a newer concept of indexing, it is referred to as the multidimensional, or multiaspect approach.

This documentation system on instruments was developed with the view that the same information may be sought from many avenues of approach. The result was a punched-card method where the card represents an index term, and the identity of the document to which the term applies is noted by punching a hole at the appropriate location on the card. The location of the hole is determined by the serial number assigned to the document. The entire system comprises a set of 5 x 8 in. index cards, a manually operated punch for cards, and a reading illuminator.

Each card carries an index term in its upper left-hand corner, and the cards are filed alphabetically within these categories: (1) Measurand (condition, physical property, quality, quantity, factor or effect to be measured or controlled); (2) principle of operation; (3) object; (4) name of instrument; (5) field of application; (6) stage in instrument development sequence; (7) function; (8) type of document; (9) instrument performance characteristics and ranges; (10) limitations on measurand.

A classifier selects descriptive index terms which best describes the information in the document, and the punch operator inserts separately into the punching machine each of the cards containing the terms chosen to index a given document. The machine positions the card and punches a small hole in it at a position determined by the serial number. Each associated card then has a hole in the same grid position. The machine is set to the next grid position, and the system is ready for indexing another document. The grid pattern provides a total of 18,000 punch positions; thus one set of index cards can accommodate a collection of 18,000 references.

To carry out a document search, the investigator removes from the file the cards containing the index terms associated with the type of references he is seeking; i.e., from category (1) (above) the condition; from category (2) principle of operation; from (3) the object (material or thing on which the observations are being made). The cards are placed in the register on the illuminator, and the position of any holes that appear illuminated are noted. The grid numbers of these holes are the serial numbers of the related documents.

Gage Numbers

Versus

Decimal Dimensions

Thickness gages for raw materials have been under attack by professional societies and the larger companies but inertia on the part of warehousemen and purchasing agents slows progress. A simple and effective technique is here described for the difficult transition period in changing from gage numbers to preferred decimal dimensions.

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THE METAL INDUSTRY and presumably many other industries are baffled by an obsolete system of designating thickness dimensions with gage numbers. Most of these systems were established when metal producers separately, or in localized groups, set up standard sizes at roughly even intervals. The multiplicity of different gage systems in use right now is fantastic.

In 1893 Congress established the U. S. Standard gage for custom purposes so devised that the intervals of weight are regular. However, it is a weight gage based on wrought iron so the thicknesses are different for other materials. Recently steel manufacturers recalculated the gage for steel and arrived at a new set of numbers, but old gage sizes are still used for all grades of stainless steel and so more confusion was created.

The Brown & Sharpe gage, or what is now known as the American wire gage, provides a constant percentage change between each gage size. This gage has been widely used in the nonferrous industry for both flat products and wire. Both the U. S. gage and the American wire gage are carried out to four decimals and yet the tolerance on the product is usually several thousandths.

Birmingham wire gage is used for some steel wire and for steel strip; American wire gage, or Brown & Sharpe gage is used for copper alloy wire, strip and copper wire; there are several music wire gages; there is a Light Metal gage which is a rounded-off American wire gage and used for aluminum and magnesium; there is a zinc gage, a tin plate gage and a galvanized sheet steel gage in addition to many special gages. One steel catalog shows a table of seven wire gages, six of which are used for steel wire of one kind or another. There is a screw gage and a drill gage; but screws get larger with increasing gage numbers and drills get smaller, and there is no relation between the gage number of a screw and the drill used as a tap drill or a clearance drill.

We cannot condemn these gage systems entirely; they were all attempts at standardization. Mills or warehouses cannot stock all the sizes that a customer might want. Earlier gages probably antedated precise measuring instruments and so were established before their exact size was known. But continuing use of gage numbers seems to be chiefly a matter of habit and inertia.

Professional societies have recognized the need for a change. The American British Canadian Committee has standardized screw threads. As early as 1941, Committee B-32, of the American Standards Association, under the sponsorship of the American Society of Mechanical Engineers and the Society of Automotive Engineers, introduced American Standard B32.1-1941—"Preferred Thickness for Thin Flat Metals." This standard provided a series of preferred sizes up to 0.250 in., based on the 20-series of American Standard proferred numbers. Each thickness is approximately the same percentage greater than the next smaller one but the sizes are rounded off to the nearest 0.001 in. to conform more closely to present manufacturing tolerances.

Experience with this standard proved it to be inadequate for two reasons. The intervals between sizes were too large and it was difficult to make the transition since the preferred numbers differed too much from the sizes already in use. In 1952 this standard was reissued as B32.1-1952. At this time the series was based on the 40-series of preferred numbers from 0.004 to 0.250 in.

Military Standard 204, 16 April, 1953, "Thickness of Sheet and Strip Metals," is based on the 20-series of preferred numbers with many of the 40-series numbers added. The introduction to this Mil Standard is worth

quoting: "The purpose of this standard is to provide a simplified system for designating the thickness of uncoated and clad sheet and strip metals and alloys. It will eliminate confusion caused by the various gage number systems used in the past, increase the availability in warehouse stocks of those thicknesses commonly required, reduce stock inventory, and facilitate interchangeability of different metals in design." This is an excellent summary of the reasons for using a system of preferred numbers for all flat metals.

As an example of the confusion cited in this Mil Standard let us suppose a designer is interested in a nominal thickness of about $\frac{1}{16}$ in. He would find:

Sheet steel 0.0590 in. (No. 16 U. S. Std. Gage (Revised)
Strip steel 0.065 in. (No. 16 Birmingham Wire Gage)
Stainless steel 0.0625 in. (No. 16 U. S. Std. Gage)
Aluminum alloys 0.064 in. (No. 14 Light Metal Gage)
Copper alloys 0.0641 in. (No. 14 American Wire Gage)

With the universal adoption of the American Standard all of these materials would be available in one size, 0.063 in.

Since the establishment of these standards, many large users of flat metal have adopted it as the basis of their standardization programs. General Electric Co., Radio Corporation of America, Westinghouse Electric Co., and Western Electric Co., have all made this change-over. Many of the aircraft companies and Ford Motor Co. have also adopted the American Standard.

Most companies using the system have picked out certain sizes which are closest to gage sizes previously used with preference given to the 20-series numbers where possible.

Present Status

With the support cited above it would appear that the battle for the acceptance of this American Standard has been won. This is far from the case. Too many competent engineers do not even know of its existence, others have not been able to use it since warehouses will not supply metal to this standard.

Most metal producers will gladly accept orders to these sizes if the orders are mill orders, which is why large metal consumers have been able to use this system while many smaller users cannot. Warehouses insist that their stocks are governed by what people order and since their catalogs show the old gage sizes, naturally purchasing agents order to the old gage sizes and no progress is possible.

Design engineers, materials engineers, and standards engineers must take the first step within their own companies. They must first sell management on the advantages of a preferred number of series for all materials. These are:

1. All materials are stocked in the same thicknesses. Besides the convenience of a single series of sizes this permits the substitution of one material for another without changing dimensions.
2. Sizes are immediately recognizable without reference to gage tables.
3. There is no possibility of getting the wrong size because of the confusion between gages.
4. A reduction in the number of stock sizes is usually possible.

Company change-overs are complicated by the large number of existing drawings which specify gage sizes. In most companies a document is issued which spells out on old parts, the ASA sizes which will be permitted as substitutes for the old gage sizes as new material is obtained, and on new parts, the gage sizes which will be acceptable as substitutes for ASA sizes during the period when the changeover is being made. A sample section from one of these documents for sheet steel as proposed in one industry is shown here.

Orders must be placed by the purchasing department for these preferred sizes. In many instances purchasing departments change requisitions and orders to gage sizes shown in warehouse catalogs and thereby defeat the program since a demand for preferred sizes never reaches the warehouses.

Having provided for the transition period within the individual organization, action may be considered for industry as a whole. On November 23, 1948, a meeting was held between the Eastern Division of the National Aircraft Standards Committee and numerous steel warehouse representatives, to discuss means for introducing the ASA thickness for 4130 aircraft quality flat steel. Aircraft companies agreed that until stocks on hand were exhausted they would accept certain U. S. gage sizes as substitutes for ASA sizes. Warehousemen agreed to stock material to ASA sizes when new material was ordered. This is probably the only item now stocked to ASA preferred sizes in warehouses.

The action taken by the aircraft industry seems to point the way. If consumer industry can agree to use these preferred number sizes and present a united front to the warehouses serving that industry and state the policy of buying future materials to ASA preferred numbers, the warehouses would agree to stock those sizes. They are in business to sell what their customers want but they must be sure they can sell it before they stock it.

This same objective could probably be achieved better in some areas of diversified industry by area action, where business and engineering associations could act as the spokesmen for the industry of an area.

International Standards

We, in this country, are not alone in facing the problem. The International Standards Organization has set up a technical committee ISO/TC62 to study the situation. In October 1951, they passed a resolution as follows: "The use of gages to designate dimensions should be discouraged."

In a later meeting of ISO/TC62 in London in January 1953, the use of the ASA series of preferred numbers was proposed by Sweden. The United States was not at that time a member of ISO/TC62 and it was the feeling of the committee that the ASA standard was not well enough established. Actually we are much farther along in this standardization than any of the other countries. Since that meeting, the United States has taken an active status on ISO/TC62 and we hope that our viewpoint will be better represented at the next meeting.

The hands of the U. S. representatives on ISO/TC62 would be greatly strengthened if we were able to say that the American Standard B32.1-1952 was in wide use in this country. It would be almost as great an accomplishment as an international language if we could arrive at an

Suggested chart provides for change-over from gage to ASA standard thicknesses showing permissible tolerances

Table I—ASA Thickness Called Out on Drawing

Thick.	Manufacturer's tolerances	Acceptable tolerances for period of transition	Acceptable reconversion thickness
0.012			
0.016			
0.020	±0.003		
0.022	±0.003		
0.025	±0.003		
0.028	±0.003		
0.032	±0.003	+0.006 −0.003	0.035
0.036	±0.003	+0.003 −0.004	0.035
0.040	±0.004	+0.006 −0.004	0.042
0.045	±0.004		
0.050	±0.004	+0.004 −0.005	0.049
0.063	±0.005	+0.007 −0.005	0.065
0.071	±0.005	±0.006	0.070 0.072
0.080	±0.006	+0.008 −0.003	0.078 0.083
0.090	±0.006	+0.011 −0.006	0.095
0.100	±0.006	+0.008 −0.011	0.095 0.102
0.112	±0.007	+0.007 −0.010	0.109
0.125	±0.007	±0.007	0.125
0.140	±0.007		
0.160	±0.008	+0.008 −0.010	0.156
0.180	±0.008		
0.200	+0.020 −0.010	+0.020 −0.015	0.187

Table II—Thickness Other Than ASA Called on Drawing

Thick.	Manufacturer's tolerances	Acceptable tolerances for period of transition	Use ASA
0.020	±0.003		
0.022	±0.003		
0.025	±0.003		
0.028	±0.003		
0.030	±0.003	+0.005 −0.003	0.032
0.035	±0.003	+0.004 −0.003	0.036
0.042	±0.004	+0.007 −0.004	0.045
0.049	±0.004	+0.005 −0.004	0.050
0.065	±0.005	+0.005 −0.007	0.063
0.072	±0.005	+0.005 −0.006	0.071
0.078	±0.006	+0.008 −0.006	0.080
0.083	±0.006	+0.006 −0.009	0.080
0.093	±0.006	+0.006 −0.009	0.090
0.095	±0.006	+0.011 −0.006	0.100
0.109	±0.007	+0.009 −0.006	0.112
0.125	±0.007		0.125
0.156	±0.008	+0.012 −0.008	0.160
0.187	±0.008	+0.008 −0.015	0.180

international standard of thickness for all flat rolled materials. We would then be ready to tackle the problem of a standard for all wire diameters.

EDITOR'S NOTE—In keeping with its policy of encouraging the acceptance of useful standards throughout the engineering profession, two editorials appeared in *Product Engineering* in recent months promoting the elimination of gage numbers in favor of standard decimal dimensions. "Standards Without Worth" appeared in June 1954 on page 127; "Start the Ball Rolling" in August 1954 on page 127.

American Standards Association recommendations for thickness dimensions of sheet metal represent a concerted effort on the part of the various societies to provide for acceptable industry-wide standards. Further progress now depends on the engineers, purchasing agents, and warehousemen who are likely to benefit most from the change.

Standardization of drafting practice is another program of direct interest to readers of *Product Engineering*. Initiated by an editorial "Expensive Fancies," in December 1953 page 127, which aroused a number of reader's comments, the newly proposed drafting techniques were compared with accepted industry standards by J. Gerardi in "Should Current Drafting Practices be Further Simplified," in May 1954 page 161. The most recent contribution to this discussion appeared in the August 1955 issue page 162, under the title, "Drafting Procedures Should be Standardized" by H. H. Ash. A note at the end of the article includes a review of the published discussion to date on drafting standards.

Simplifying Assemblies With

Since annealed spring steel can be stamped, twisted, or bent into any desirable shape and heat-treated to develop spring characteristics, it can be designed for multiple functions in addition to that of fastening. Shown below are 16 ways in

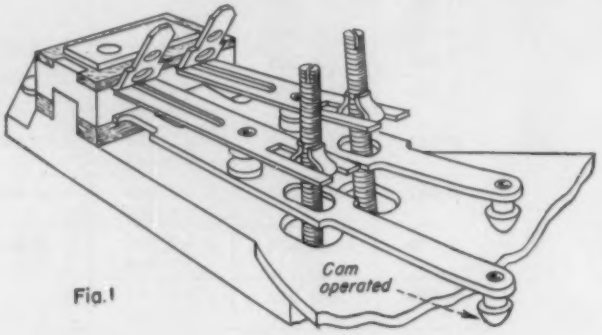


Fig. 1

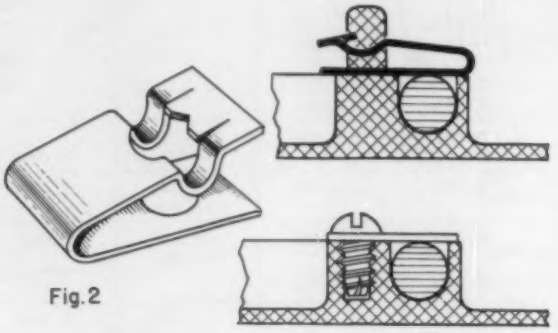
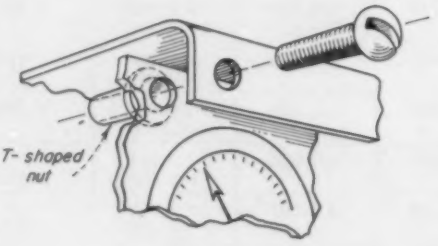


Fig. 2



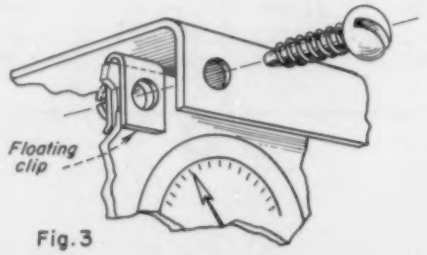
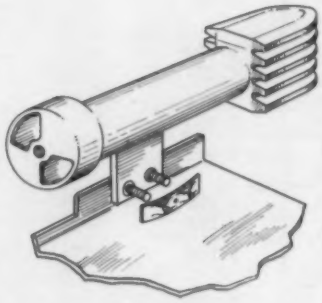


Fig. 3



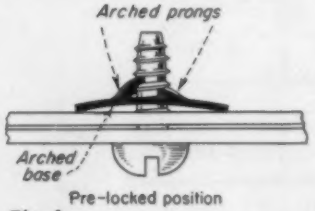


Fig. 4

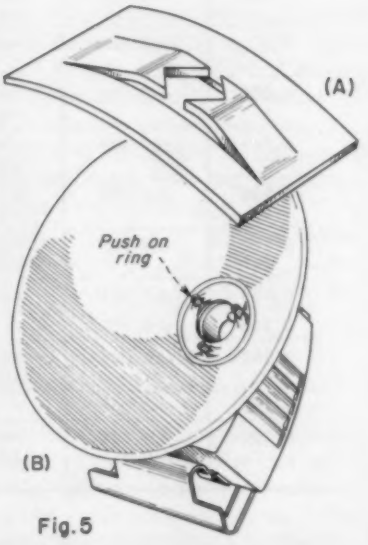


Fig. 5

FIG. 1—Multiple-purpose flat spring has stamped hole helically formed to accept adjusting screw. Replaces a locknut, bushing with internal threads and spring blade. Screw adjusts gap of contacts thus changing duration of current flow. Application: thermostatic control unit of an automatic percolator.

FIG. 2—Spring-steel clip firmly holds stud of control knob while allowing it to turn freely on its bearing surface. Clip is removed by merely compressing spring arms and lifting off stud. Replaces screw and machined plate.

FIG. 3—Floating clip, which snaps in place by hand, reduces hole misalignment problems by permitting sufficient shift of mounting holes to offset normal manufacturing tolerances of main parts. Replace welded T-shaped nuts.

FIG. 4—Twin-hole nut removes need for hand wrench in hard-to-reach location and replaces two nuts and lockwashers. Combined force of arched prongs and base when nut is compressed creates high resistance to vibration loosening. Application: burner assembly of an automatic clothes dryer.

FIG. 5—Push-on nuts (A) easily press over studs, rivets, tubing and other unthreaded parts. Their steel prongs securely bite into smooth surfaces under load. Application: (B) triple-hole push-on ring on a flash bulb reflector.

FIG. 6—Previous method of assembling desk calendar (A) required seven parts: wire guide, spring clip, plate, two bolts and two nuts. Multi-purpose spring clip (B) replaces above although using same retaining principle.

Spring-Steel Fasteners

TINNERMAN PRODUCTS, INC.

which spring-steel fasteners can be used to: Compensate for hole or part misalignment; prevent vibration loosening; eliminate parts; speed assembly; lock on unthreaded studs or tubing; and permit blind installations.

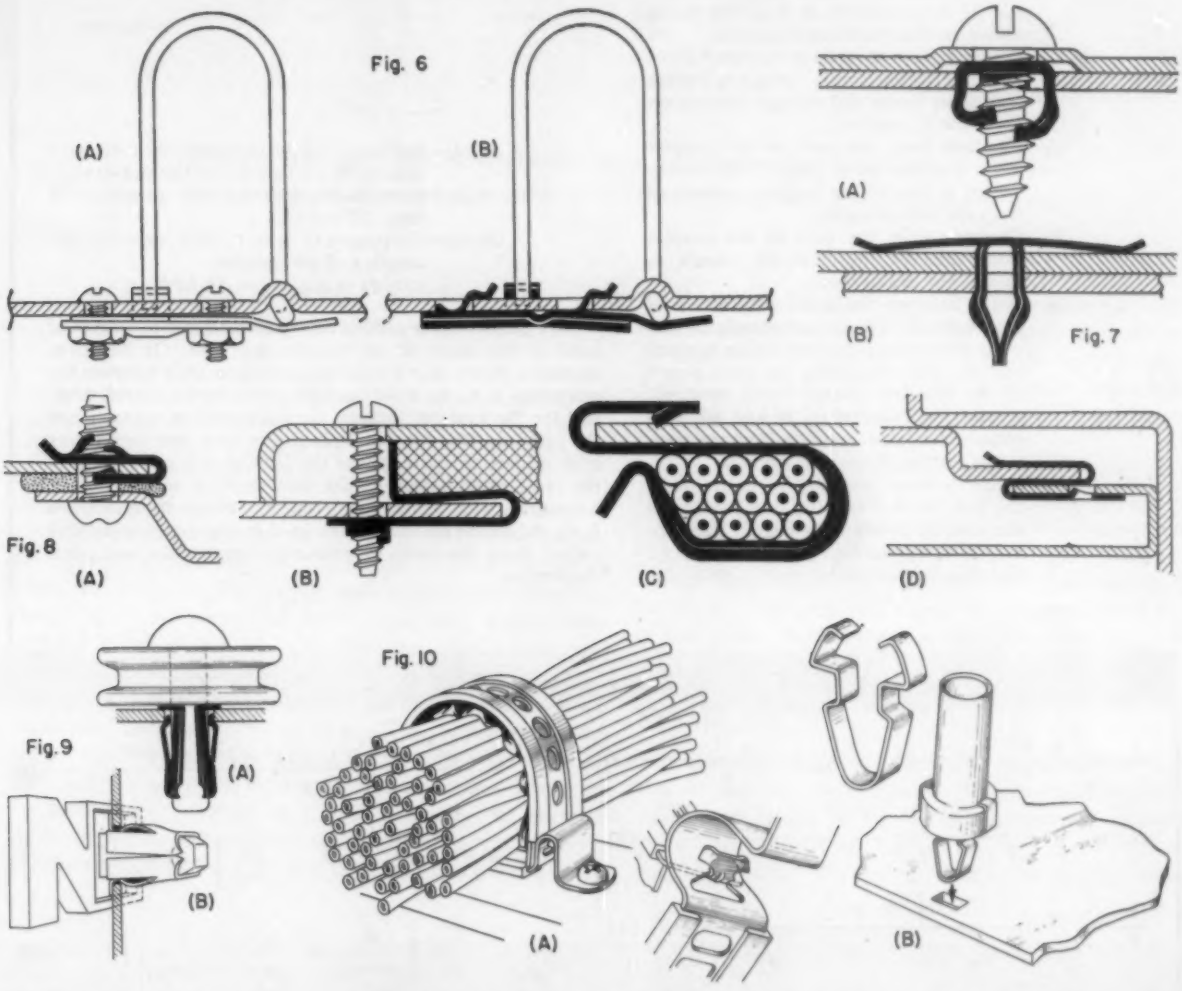


FIG. 7—Expansion-type fastener permits blind installation where access is from one side of an assembly only. Insertion of screw (A) spreads fastener arms apart thus producing a wedging effect in the hole. Dart-type fastener (B) can be quickly snapped in place and is used for attaching molding strips to panels.

FIG. 8—End clips pressed by hand on panel edges have barbed retaining leg which either bites into the metal or snaps into a mounting hole. Applications: (A) sheet metal screw and J-clip with arched prongs compresses insulating material between panels; (B) bent leg of clip acts as spacer between two panels to support sheet of insulating material; (C) barbed-leg-clip retains wires without need for mounting hole; (D) S-clip secures removable panel in inaccessible position.

FIG. 9—Tubular-type fastener has cam-like prongs which spring out after insertion to hold fastener in position. Applications: (A) radio dial pulley; (B) automotive name plate.

FIG. 10—Special-function fasteners for quick assembly and disassembly of components. (A) Wire harness clamp using torque and slot principle; (B) dart-shaped clip for attaching coils to television or radio chassis.

FOUR-BAR LINKAGE NOMENCLATURE

$\Psi = f(\varphi)$—Function to be mechanized (after a coordinate transformation if necessary).

Ψ', Ψ'', Ψ''', etc. First, second, third, and fourth derivatives of Ψ with respect to φ.

g—Length of the fixed link

U_g—Distance from the instant center of output link relative to input link (mechanism in the design position) to the fixed pivot A_o of the input crank of the four bar linkage being designed. The sign of polar coordinates is used in locating convention A_o. The instant center corresponds to the pole of the polar coordinate system. If U_g is positive, A_o is on the radius vector which is located by the angle α_g. If U_g is negative, A_o is on the radius vector produced through the pole.

V_g—Distance from the pole to the fixed pivot B_o of the output crank. Angle α_g locates the radius vector and the sign convention given for U_g applies.

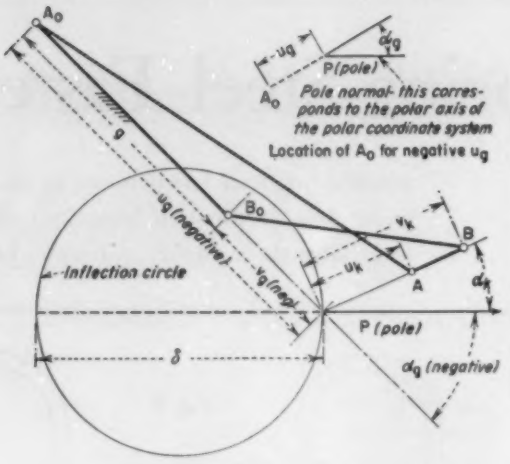
U_k—Distance from the pole to the coupler joint A of the input crank. The radius vector is located by angle α_k measured from the pole.

V_k—Distance from the pole to the coupler Point B of the output crank. Angle α_k locates the radius vector.

α_g—Angle between the positive direction of pole normal (which corresponds to the polar axis of the polar coordinate system) and the line containing the fixed pivots of the four bar linkage being designed. A positive value of α_g is laid off in a counterclockwise direction from the positive direction of the pole normal.

α_k—Angle between the positive direction of the pole normal and the line containing the coupler joints of linkage. The sign convention given for α_g applies.

δ—Dia of inflection circle.



$d\delta/ds$—Derivative of the inflection circle dia with respect to arc length s of the polodes.

θ_a, θ_b—Symbols representing the quantities of Eqs. (5) and (6).

$d\theta/ds$—Derivative of θ_a or θ_b with respect to arc length s of the polodes. ($d\theta/ds = d\theta_a/ds = d\theta_b/ds$)

No expressions for radii of curvature and rate of change of radii of curvature of the polodes are used. It has been shown by Sieker that if there is a correspondence between the quantities δ, θ_a, θ_b, $d\delta/ds$ and $d\theta/ds$ for the cam mechanism and for the four bar linkage, then the radii of curvature of the polodes of the four bar linkage and their first derivatives with respect to arc length of the polodes will correspond to the radii of curvature of the cam outlines and their first derivatives with respect to arc length. Hence the quantities δ, θ_a, θ_b, $d\delta/ds$ and $d\theta/ds$ are used in the design equations rather than the radii of curvature expressions and their derivatives.

TABLE I - DESIGN EQUATIONS

$$U_g = \frac{g\,\psi'}{1-\psi'} \qquad (1)$$

$$V_g = \frac{g}{1-\psi'} \qquad (2)$$

$$\tan\alpha_g = \frac{\psi''}{\psi'(1-\psi')} \qquad (3)$$

$$\frac{1}{\delta} = \pm \frac{\frac{1}{g}(1-\psi')^3}{\sqrt{\psi'^2(1-\psi')^2 + \psi''^2}} \qquad (4)$$

$$\theta_a = \frac{\psi'^2(1-\psi')(2-\psi') + 3\psi''^2 - \psi'\psi'''}{\psi'^2(1-\psi')^2 + \psi''^2} \qquad (5)$$

$$\theta_b = \frac{\psi'^2(1-\psi')(2\psi'-1) - \psi'\psi'''}{\psi'^2(1-\psi')^2 + \psi''^2} \qquad (6)$$

$$\frac{d\delta}{ds} = \delta \sin\alpha_g \left[\frac{\theta_a}{V_g} - \frac{\theta_b}{U_g}\right] \qquad (7)$$

$$\frac{1}{U_g} = \frac{1}{3\delta}\left[\frac{\theta_a}{\cos\alpha_g} + \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin\alpha_g}\right)\right] \qquad (8)$$

$$\frac{1}{V_g} = \frac{1}{3\delta}\left[\frac{\theta_b}{\cos\alpha_g} + \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin\alpha_g}\right)\right] \qquad (9)$$

$$\frac{d\theta}{ds} = \frac{\tan\alpha_g}{\delta}\left[2\theta_a\theta_b + \frac{\psi'^2\left[4(1-\psi')^2 - \psi'\right] + 5\psi'\psi''' - \left(\frac{\psi'^2\psi''''}{\psi''}\right)}{\psi'^2(1-\psi')^2 + \psi''^2}\right] \qquad (10)$$

$$\left(\frac{d\delta}{ds}\right)^2 - \left(\theta_a + \theta_b\right)\left(\frac{d\delta}{ds}\right)\tan\alpha + \left[2\left(\frac{d\delta}{ds}\right)^2 - 3\delta\left(\frac{d^2\delta}{ds^2}\right)\right]\tan^2\alpha - 3\delta\left(\frac{d\theta}{ds}\right)\tan^3\alpha + \theta_a\theta_b\tan^4\alpha = 0 \qquad (11)$$

$$\frac{1}{U_k} = \frac{1}{3\delta}\left[\frac{\theta_a}{\cos\alpha_k} + \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin\alpha_k}\right)\right] \qquad (12)$$

$$\frac{1}{V_k} = \frac{1}{3\delta}\left[\frac{\theta_b}{\cos\alpha_k} + \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin\alpha_k}\right)\right] \qquad (13)$$

Four-Bar Linkages... ...as function generators

A simple, systematic method applicable when a given function must be generated precisely at one point, and yet accurately over a limited range in the vicinity of that point.

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DEPENDING UPON THE REQUIREMENTS, bar linkages to be used as input-output devices can be designed by one of several methods. For example, if the angular relationship between the input and output crank is specified for a limited number of positions, an exact geometric method is available such as offered in *Angewandte Getriebelehre*, Kurt Hain, Herman Schrodel Verlag, K. G., Hanover, 1952, pages 277-281. If the output and input crank displacements must be correlated at all positions, approximate techniques are described in *Computing Mechanisms and Linkages*, Antanin Svoboda, McGraw-Hill Book Co., Inc., New York, 1948. (Massachusetts Institute of Technology, Radiation Laboratory Series, Vol. 27.) However, if the output and input crank displacements must be matched accurately only in the vicinity of one point and need not be held closely outside of a limited range, the method described below will reduce calculations to a routine form.

The theoretical basis for this approach was developed by K. H. Sieker, "Ermittlung von Gelenkvierecken aus den Krummungshalbmessern der Pohlbahnen und deren Anderungen," *Die Technik*, Bd. 3, Nr. 4, April 1948, pages 170-174. Basically, it shows that a four-bar linkage can be replaced by a rolling-contact cam mechanism such as that shown in Fig. 1.

The cam curves are determined from the given function and the four-bar linkage is designed having polodes corresponding with these curves both in radius of curvature and rate of change of curvature at the design position. The linkage then will generate the given function exactly at the design position and very closely in the immediate vicinity of this point. Table I lists the equations necessary to design such a linkage.

EXAMPLE 1

A four-bar linkage is to generate the function $y = x^n$ in the vicinity of $x = 1$, $y = 1$. The function is plotted in (x, y) coordinates in Fig. 2. Introducing new coordinates (ϕ, ψ), the point $x = 1$, $y = 1$ of the (x, y) system is at the origin of the new system. Then, the problem of mech-

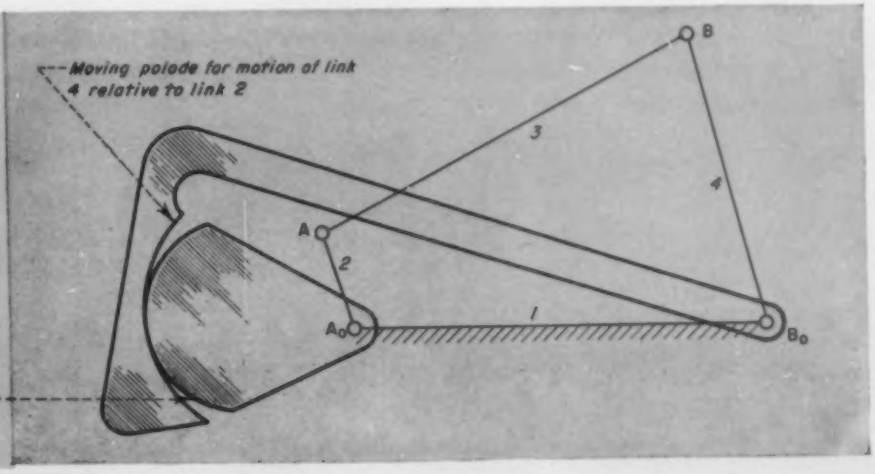


Fig. 1—Four bar linkage (A_o A B B_o) and equivalent cam mechanism. The cam curves are the fixed and moving polodes (centrodes) for the motion of output link 4 with respect to input crank 2.

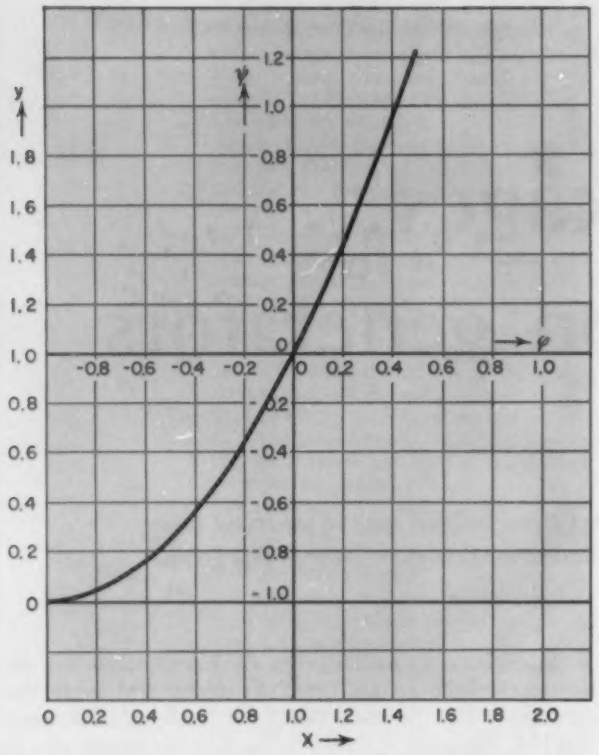


Fig. 2—First step in design of a linkage to mechanize a function at a given point is to transform axes so that the point falls at the origin of the new system. Above, function $y = x^3$ is plotted in the original (x, y) and the new (ϕ, ψ) coordinate systems.

anizing $y = g(x)$ at (x_o, y_o) becomes one of mechanizing $\psi = f(\phi)$ at $(0, 0)$.

The next step is to determine the function $\psi = f(\phi)$. The equations for the translation of axes are

$$x = \varphi + 1$$
$$y = \psi + 1$$

Substituting these values of x and y into $y = x^3$

$$\psi = \varphi^3 + 2\varphi$$

If a linkage is designed to generate this function in the vicinity of (0, 0), it will generate $y = x^3$ in the vicinity of $x = 1$, $y = 1$.

The first four derivatives of ψ are: $\psi' = 2\phi + 2$, $\psi'' = 2$, $\psi''' = 0$, and $\psi'''' = 0$.

At $\phi = 0$ and $\psi = 0$: $\psi'(0) = 2$, $\psi''(0) = 2$, $\psi'''(0) = 0$, and $\psi''''(0) = 0$.

Choosing an arbitrary value of 6 in. for g, the length of the fixed link, Eqs (1) and (2) become:

$$U_o = \frac{g\psi'}{1 - \psi'} = \frac{6 \times 2}{1 - 2} = -12 \text{ in.}$$

$$V_o = \frac{g}{1 - \psi'} = \frac{6}{1 - 2} = -6 \text{ in.}$$

Angle α_g between the pole normal and line of fixed pivots $A_o - B_o$ is determined with Eq (3)

$$\tan \alpha_g = \frac{2}{2(1 - 2)} = -1$$

$$\alpha_g = -45 \text{ deg}$$

The diameter of the inflection circle can be determined from Eq (4):

$$\delta = \pm 16.968 \text{ in.}$$

θ_a, θ_b and $d\delta/ds$ are found with Eqs (5), (6) and (7)

$$\theta_a = 1.5, \qquad \theta_b = -1.5, \qquad d\delta/ds = \pm 4.500$$

(For this problem, $d\delta/ds$ is positive if δ is positive, and negative if δ is negative.)

Values obtained for θ_a and θ_b can be checked with the relationship

$$\theta_a - \theta_b = 3$$

The values of θ_a and θ_b obtained above satisfy this expression.

Next, the signs of δ and $d\delta/ds$ are determined. There are two possibilities

$$\delta = +16.968, \qquad \frac{d\delta}{ds} = +4.500, \text{ and}$$

$$\delta = -16.968, \qquad \frac{d\delta}{ds} = -4.500$$

To determine which is correct, find which set of values satisfies Eqs (8) and (9). Substituting $\delta = +16.968$, $d\delta/ds = +4.500$, and $U_o = -12$ into Eq (8) with the other calculated values,

$$-\frac{1}{12} = \frac{1}{3 \times 16.968}\left[\frac{1.5}{0.7071} + \frac{4.500}{-0.7071}\right]$$

or

$$-0.0833 = -0.0833$$

Substituting the minus values into Eq (8) would result in an inequality, proving that the positive values are correct. This can be verified using Eq (9) as a second check.

From Eq (10)

$$d\theta/ds = 0.2062$$

Substituting the values of θ_a, θ_b, δ, $d\delta/ds$ and $d\theta/ds$ in Eq (11), $20.241 + [40.482 - 50.904\ d^2\delta/ds^2] \tan^2 \alpha - 10.496 \tan^3 \alpha - 2.250 \tan^4 = 0$

This is a fourth degree equation in tan α, and tan α_g is one solution. For tan $\alpha_g = -1$

$$d^2\delta/ds^2 = 1.399$$

Substituting this value into the above equation

$$20.241 - 30.733 \tan^2 \alpha - 10.496 \tan^3 \alpha - 2.250 \tan^4 \alpha = 0$$

A fourth degree equation which has one real solution will have at least one more real solution; tan $\alpha_g = -1$ is one solution and a second, tan α_k is found by one of the known methods for solving higher degree equations, such as successive approximations. For example, tan $\alpha_k = 0.7167$ satifies the equation and

$$\alpha_k = 35° 38'$$
$$\sin \alpha_k = 0.5825$$
$$\cos \alpha_k = 0.8128$$

Then, using Eqs (12) and (13)

$$U_k = +5.320, \qquad \text{and} \qquad V_k = +8.659$$

The linkage can now be laid out as shown in Fig. 3(A). For a check, compare the generated with the desired function. Taking clockwise rotation of the cranks as positive, the rotation of the output crank in radians is plotted for this example in Fig. 3(B) against the rotation of the input crank.

EXAMPLE 2

A four bar linkage with an almost constant velocity ratio, over a limited range is to replace the gear segments of Fig. 4(A). Since $\omega_{out}/\omega_{in} = A_o P/B_o P = -2$, the function to be mechanized is $\psi = -2\phi$ where ψ is the output rotation angle and ϕ is the input rotation angle.

Proceeding as before

$$\psi' = -2, \quad \psi'' = 0, \quad \psi''' = 0, \quad \text{and} \quad \psi'''' = 0$$

The length of g, the fixed link, is equal to the distance between centers of the gears—or 6 in. Then from Eqs (1) and (2)

$$U_o = -4$$
$$V_o = 2$$

Eq (3) gives $\tan \alpha_o = \frac{\psi''}{\psi'(1-\psi')} = 0$. Therefore, $\alpha_o = 0$ deg. The diameter of the inflection circle from Eq (4) is

$$\delta = \pm 1.333 \text{ in.}$$

From Eqs (5) and (6)

$$\theta_a = 4/3, \quad \text{and} \quad \theta_b = -5/3$$

Checking by the equation $\theta_a - \theta_b = 3$,

$$4/3 - -5/3 = 3$$

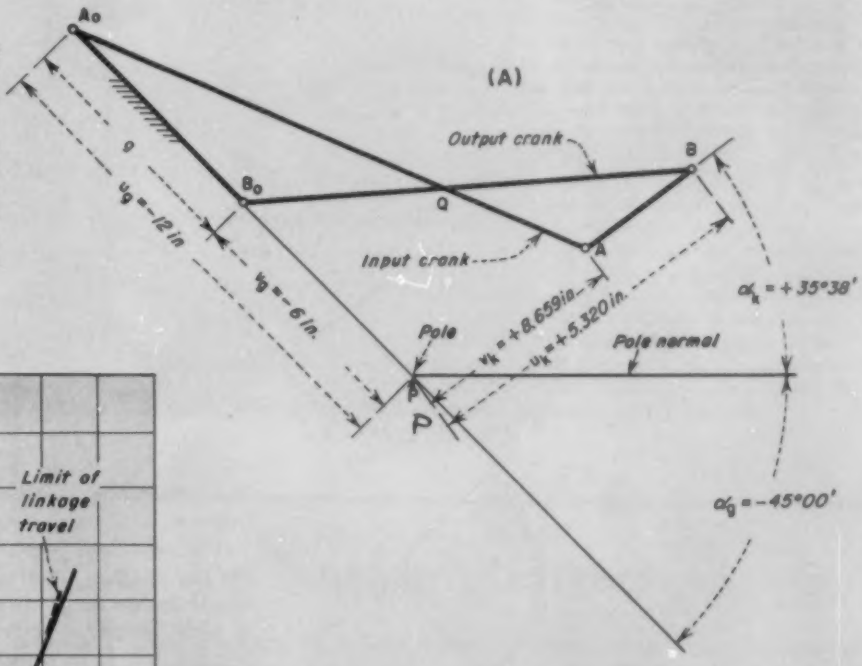
From Eq (7), dividing by $\sin \alpha_o$,

$$\left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin \alpha_o}\right) = \pm 0.333$$

As before, there are two possibilities for the signs of δ and $\left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin \alpha}\right)$

$$\delta = +1.333, \quad \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin \alpha_o}\right) = +0.333$$

$$\delta = -1.333, \quad \left(\frac{d\delta}{ds}\right)\left(\frac{1}{\sin \alpha_o}\right) = -0.333$$



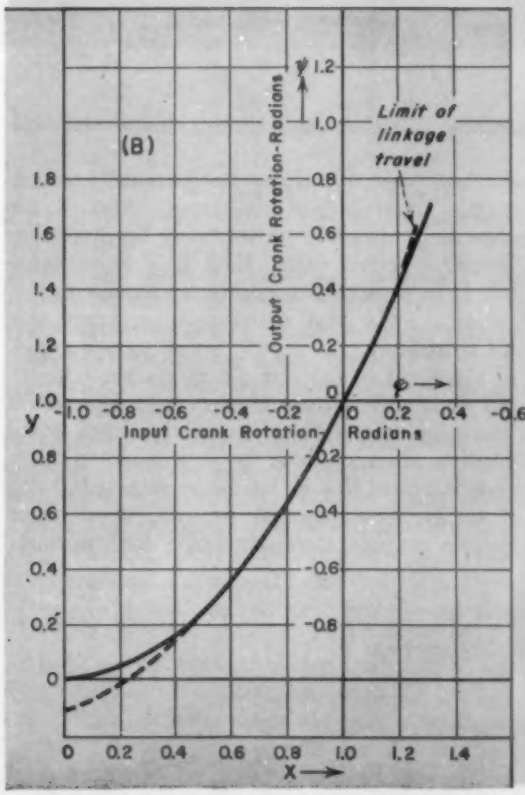


Fig. 3—Four-bar linkage that will generate $y = x^2$ at the point $x = 1$, $y = 1$. Chart compares function to be mechanized ($y = x^2$ or $\psi = \phi^2 + 2\phi$ and function actualy generated represented by dashed line. This demonstrates the accuracy of the method when only a limited range of travel on either side of the design point is involved.

x	y	φ $(x-1)$	Ψ $(y-1)$	Input Angle (Rad.)	Output Angle (Rad.)
0	0	−1.00	−1.00	−1.00	−1.11
0.10	0.01	−0.90	−0.99	−0.90	−1.07
0.20	0.04	−0.80	−0.96	−0.80	−1.02
0.30	0.09	−0.70	−0.91	−0.70	−0.95
0.40	0.16	−0.60	−0.84	−0.60	−0.86
0.50	0.25	−0.50	−0.75	−0.50	−0.75
0.60	0.36	−0.40	−0.64	−0.40	−0.64
0.70	0.49	−0.30	−0.51	−0.30	−0.51
0.80	0.64	−0.20	−0.36	−0.20	−0.36
0.90	0.81	−0.10	−0.19	−0.10	−0.19
1.00	1.00	0	0	0	0
1.10	1.21	0.10	0.21	0.10	0.21
1.20	1.44	0.20	0.44	0.20	0.44
1.25	1.56	0.25	0.56	0.25	0.50
1.26	1.59	0.26	0.59	0.26	0.61

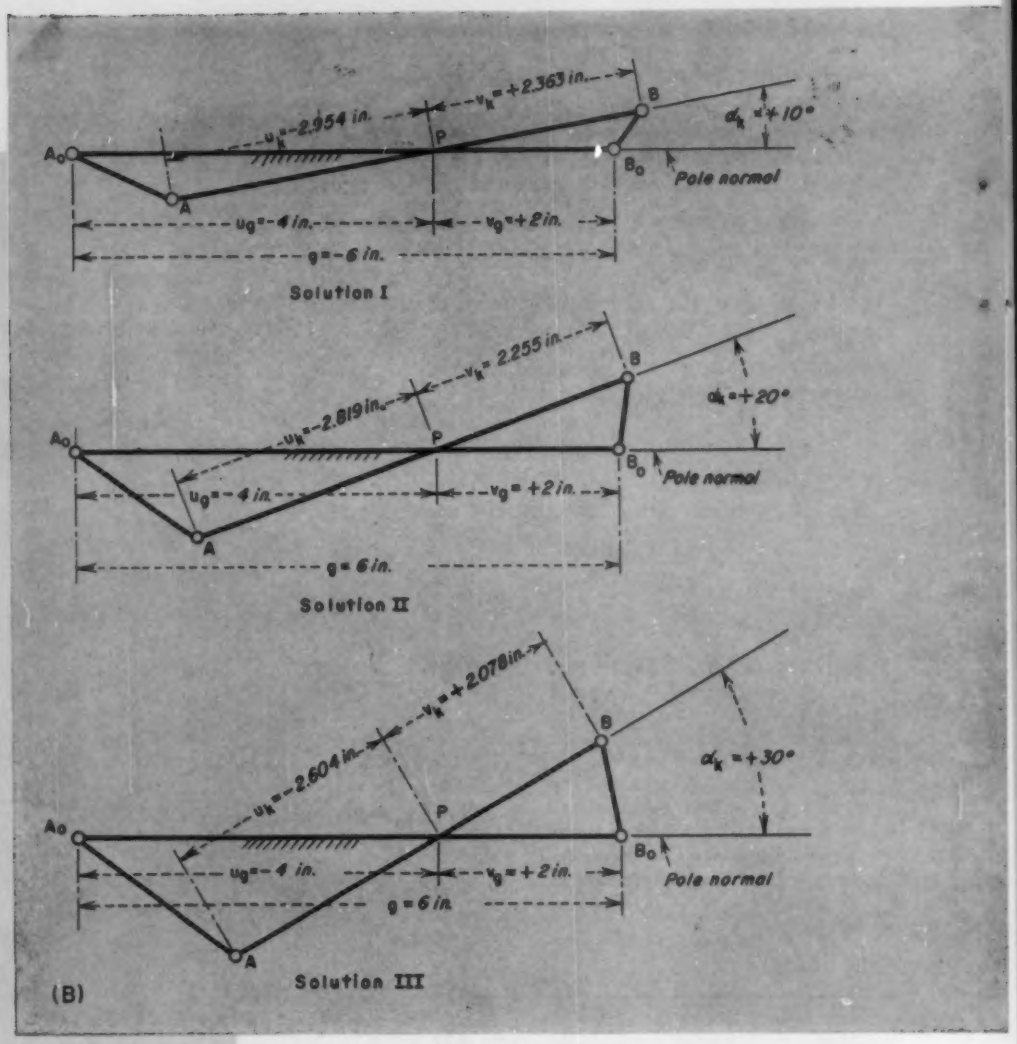
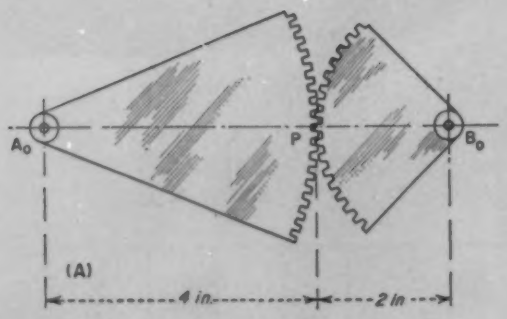


Fig. 4—Typical application of this method of designing generating types of linkages involves replacing gear segments shown in (A) with a four-bar linkage. Three solutions to the problem are shown in (B); the top mechanism is for $\alpha_k = 10$ deg, the middle one for $\alpha_k = 20$ deg, and the bottom one for $\alpha_k = 30$ deg. The output curves for all three are compared to the desired function, $\psi = -2\phi$, in (C). For practical considerations, α_k is usually chosen as 30 deg, although it is possible to use values up to 60 deg.



That δ must be negative can be confirmed by substituting in Eqs (8) and (9).

From Eqs (7) and (10), $d\delta/ds = 0$ and $d\theta/ds = 0$. Substituting θ_a, θ_b, δ, $d\delta/ds$ and $d\theta/ds$ into Eq (11)

$$-3 \times -0.333 \left(\frac{d^2\delta}{ds^2}\right) \tan^2 \alpha + \frac{4}{3}\left(-\frac{5}{3}\right) \tan^4 \alpha = 0$$

If $\tan \alpha_g = 0$ is substituted for $\tan \alpha$ in this equation and $d^2\delta/ds^2$ computed, any value of $d^2\delta/ds^2$ will satisfy the equation. Hence any value of $d^2\delta/ds^2$ could be assumed, and, proceeding as before, $\tan \alpha_k$ could be evaluated and hence α_k.

The smaller $d^2\delta/ds^2$, the closer the generated function fits the desired function over some range, although the actual usable range may not be increased by decreasing $d^2\delta/ds^2$ beyond a certain value. If $d^2\delta/ds^2$ is set equal to zero, $\tan \alpha_k = 0$ and the resulting mechanism in the design position is in a dead center position; hence this value is not satisfactory.

Since it is difficult to determine a reasonable value of $d^2\delta/ds^2$ and since angle α_k, whose magnitude depends directly on the magnitude of $d^2\delta/ds^2$, can be pictured physically, it is best to assume a value for angle α_k.

Experience indicates that α_k can be as large as 60 deg but it is usually more practical to limit it to about 30 deg. For this example, three values of α_k are compared:

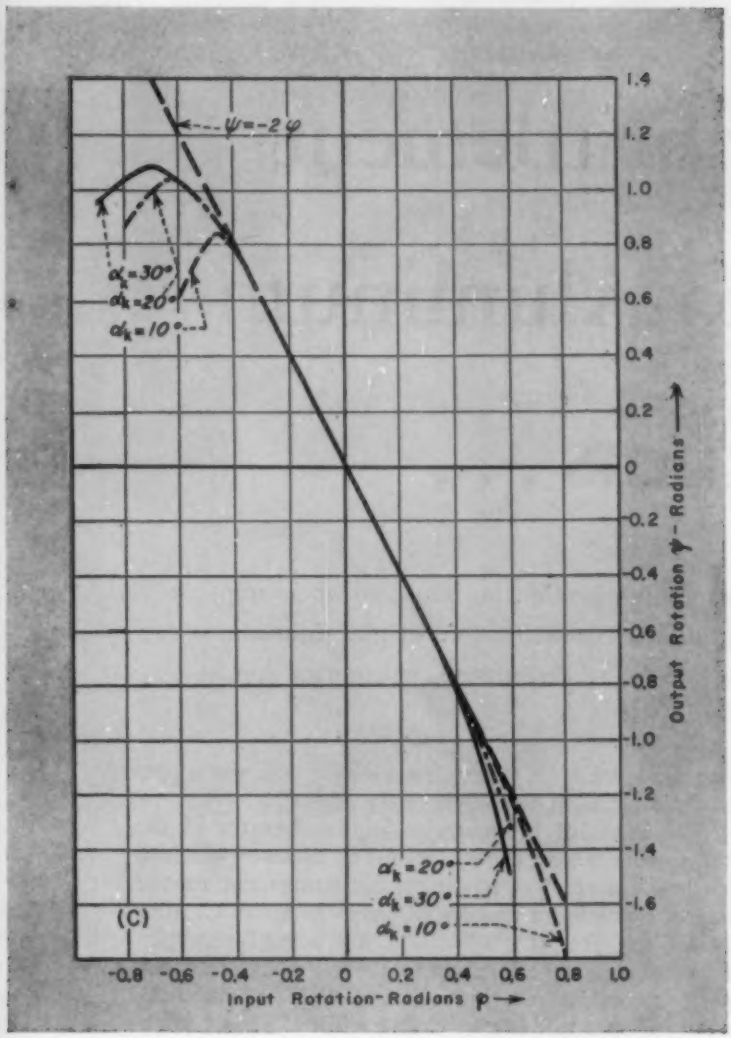
Case I

If $\alpha_g = +10$ deg, $\sin \alpha_g = +0.1737$, and $\cos \alpha_k = +0.9848$. Then, from Eq (12)

$$U_k = -2.954 \text{ in.};$$

and from Eq (13)

$$V_k = +2.363 \text{ in.}$$



Case II

With $a_k = +20$ deg, $\sin a_k = +0.3420$, and $\cos a_k = +0.9397$. Similarly

$$U_k = -2.819 \text{ in.}; \quad \text{and} \quad V_k = +2.255 \text{ in.}$$

Case III

If $a_k = 30$ deg, $\sin a_k = +0.5000$, and $\cos a_k = +0.8660$. Then,

$$U_k = -2.604 \text{ in.}; \quad \text{and} \quad V_k = +2.078 \text{ in.}$$

The linkages for the three conditions are shown in Fig. 4(B). Taking clockwise rotation of the cranks as positive, the rotation of the output cranks are plotted against the rotation of the input cranks in Fig. 4(C). The usable range of the linkage is increased by decreasing a_k from 30 to 10 deg. However, the cranks become quite short at the smaller angles and the linkage with $a_k = 30$ deg may actually be the best considering all factors.

EDITOR'S NOTE—Linkage design has been and probably still is more of an art than a science. Most designers rely on trial-and-error techniques and past experiences rather than rigorous solutions. This, of course, has serious drawbacks. To aid in simplifying and rationalizing linkage design, *Product Engineering* has published a continuing program of articles including:

"Linkage Design Techniques," by J. C. Wolford and J. C. Nicklas, December 1954 page 133. A comparison of four methods—two approximate and two exact—for the design of four-bar linkages that generate a path passing through given points.

"Linkage Requirements Solved Mathematically," A. Kuhlenkamp, Aug. 1955 page 165, shows how number and types of links required to generate given motions can be expressed in equation form. Design then resolves to a problem of combining these links into a satisfactory form. The method is demonstrated by the author for the design of a differential mechanism.

"Spring Actuated Linkage Analysis to Increase Speed," by R. C. Van Sickle, July 1953 page 152. How a circuit-breaker mechanism was redesigned for higher operating speed; design procedure for general application of the method.

New Alloy for Nuclear Reactors

AT THE RECENT GENEVA MEETINGS on Nuclear Power, much time was devoted to the discussion of new metals and alloys for use in nuclear reactors. One of the new alloys announced was a zirconium alloy, which was developed by the atomic power division of Westinghouse Electric Corporation. Called Zircaloy-2, the new alloy contains 1.5 per cent Tin, 0.12 per cent Iron, 0.10 per cent Chromium, and 0.05 per cent Nickel, and is said to be so resistant to the extremely corrosive action of high temperature, high pressure water in nuclear reactors, that in a year's time only ten-thousandths of an inch of corrosion can be measured. The announcement of the new alloy was made by Dr. D. E. Thomas, manager of the metallurgy section for the large ship reactor project at Westinghouse. His paper was titled, "Aqueous Corrosion of Zirconium and its Alloys at Elevated Temperatures."

During the early stages of research on the alloy, it was found that the corrosion resistance of zirconium was greatly affected by infinitesimal amounts of impurities. For example, a small amount of nitrogen mixed with a large quantity of zirconium would make the difference between complete disintegration within a day, and a life of several years in high temperature water.

Two operations were necessary to make pure zirconium. The Kroll process was used first. Here, zirconium chloride is reacted with magnesium to form sponge zirconium. To purify this further, the deBoer process was used, in which zirconium iodide was converted to metal on a white-hot zirconium wire.

As the pure metal did not have good enough corrosion resistance, small amounts of other metals were added to the zirconium to make the corrosion-resistant alloys. Many of the alloying elements were useless, because their capacity for capturing neutrons was so great that a nuclear chain reaction would not be possibble. Also, many of the added elements destroyed the corrosion resistant properties of zirconium.

Of all the elements examined, tin was found best.

Preventing Embrittlement in Copper-to-Aluminum Weld Joints . . .

• • • by avoiding critical time-temperature conditions during required operating life. Joint embrittlement results from logarithmic growth of a brittle diffusion layer. Safe temperature-with-time data are given, as determined by impact test.

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GROWING USE OF ALUMINUM for such applications as refrigerator evaporators and electrical conductors has directed increased attention to the problem of joining aluminum and copper. One method of simplifying production joining operations is the use of a "transition" section, a short length of aluminum wire or tubing flash welded to a short copper section. Thus, conventional aluminum-to-aluminum and copper-to-copper joining methods can be applied to either end of the transition section, and the more difficult aluminum-to-copper joint can be produced under more readily controlled conditions.

These copper-to-aluminum transition joints stand up well under moderate heat conditions, even for prolonged periods; for example, on several 65,000 kw hydrogen-cooled turbo-generators, such joints have remained ductile for 20 years and have given no evidence of embrittlement at an operating temperature of 80 C. However, when such joints were heated to 175 C or above, even for short periods, they became embrittled. This embrittlement was a more serious problem during inert-gas welding of a transition joint to the aluminum winding of a transformer —so great that often a light hammer tap caused the joint to fall apart. Temperatures at the aluminum-copper transition joint, measured during the subsequent welding operation, were found to reach as high as 510 C.

Embrittlement Measurement

Neither tensile nor bend tests were found to give definite indication of embrittlement to be expected with aging of the joint; however, an impact test, as shown in Fig. 1, proved effective in making this determination. The specimens were clamped in the jaw of the test apparatus as shown, with the joint aligned with the top of the anvil. Specimens were $\frac{1}{4} \times \frac{1}{2}$ in. in cross-section, and the copper segment extended 1.1 in. above the anvil.

The as-welded before-service impact strengths of the test specimens were 15 to 17 ft-lb. Test data were obtained to show the effect of service (aging) temperature on the impact strength, for temperatures from 75 to 525 C. After "aging" for 500 days, no change was noted for samples subjected to temperatures up to 125 C. Above this temperature, embrittlement was observed. At 250 C embrittlement occurred in 24 hours or less; while at 525 C, joints became brittle in seconds.

Photomicrographs of samples, aged at 215 C for times ranging from $\frac{1}{2}$ to 28 days, showed that embrittlement is caused by growth of inter-metallic compounds at the joint. The diffusion layer varied in thickness from 0.00002 in. at time of welding to 0.00009 in. after aging 28 days, as shown in the photomicrographs, Fig. 2. As revealed by micro-hardness tests, the diffusion layer was very hard, averaging 764 Knoop Hardness under 25 gram load, while the copper (Knoop 104) and aluminum (Knoop 44) remained ductile.

Design Criteria

Based on the impact test data obtained, the curve of Fig. 1 is the dividing line between ductile and brittle joints. Operating or service temperature and required life at such temperature are dependent variables; combinations that give points below the line produce ductile joints, while those above the line may give rise to excessive embrittlement.

The dividing line shown passes through data points that represent a drop in impact strength of the sample test joints from "as welded" values (15-17 ft-lb) to 14 ft-lb. Points representing test values as low as 8 or 10 ft-lb (high brittleness) would fall very close to this line; thus, this graph can be used for all practical applications, regardless of the degree of embrittlement that can be tolerated.

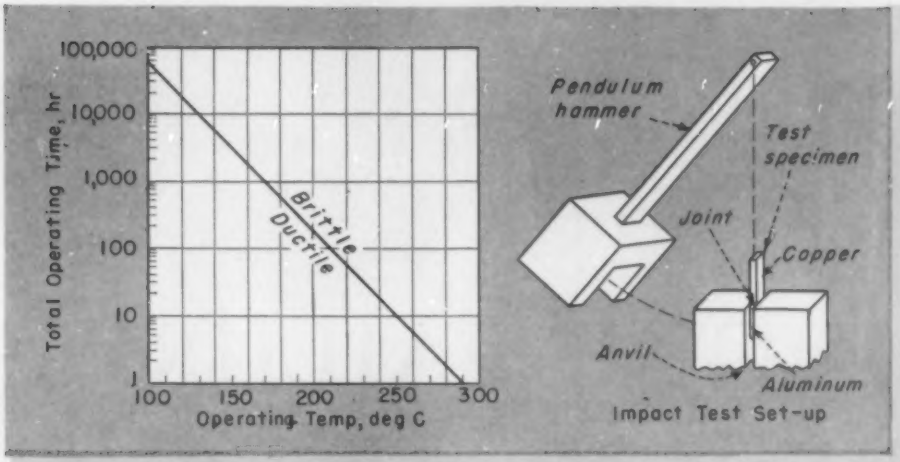
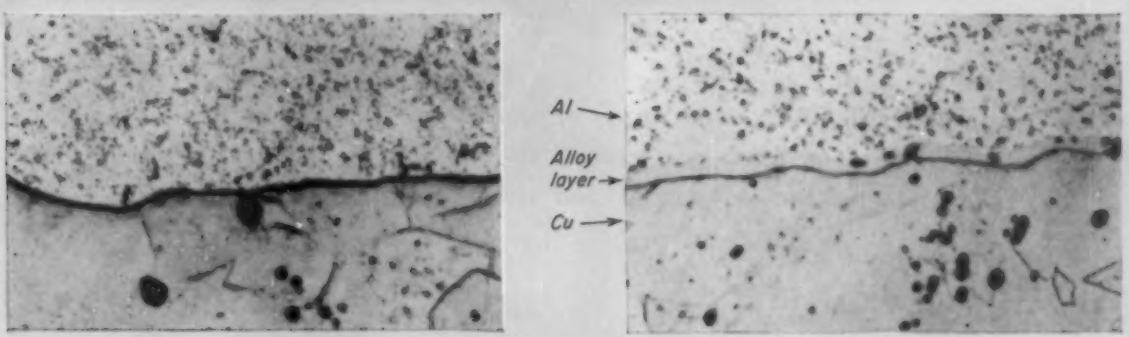


Fig. 1—Aluminum-to-copper joint design chart for determining maximum service temperature allowable for a given required joint life. No excessive embrittlement results when design points fall below the curve or dividing line of the graph. Data for the chart was obtained by impact testing of many samples at various temperatures from below 100 C to 525 C, using technique illustrated.



(A) Immediately after welding

(B) After being subjected to "in-service" temp of 215 C for 28 days

Fig. 2—These sectional photomicrographs of an aluminum-to-copper joint show how the alloy layer between the base metals grows with time at a given "in-service" aging temperature. When first welded, the alloy diffusion layer is not over 0.00002 in. thick and is hardly visible in photomicrograph A. After aging for 28 days at 215 C, the diffusion layer, now 0.00009 in. thick, is clearly visible as at *B*.

In flash-welding, heat for melting the end-surfaces of the pieces to be joined is obtained from a succession of arcs which increase in number and intensity as the surfaces slowly approach each other. The approach is accelerated during the flashing period, and at current cut-off a sudden increase in speed and force produces a high forging pressure. This sudden impact ejects slag, oxides, and molten metal, leaving only a very thin layer of alloy in the joint. The self-cleaning nature of the flash-welding process is the principal reason a satisfactory joint between aluminum and copper can be made. The resulting thin alloy layer, Fig. 2, is brittle as welded; yet, the overall strength of joint is unaffected so long as the layer thickness does not exceed 0.00004 in. Embrittlement of a good flash-welded aluminum-to-copper joint occurs subsequent to welding.

Copper-aluminum, like most binary metal systems, shows partial solubility in the solid state. Copper and aluminum diffuse into each other, forming an alloy layer which increases in thickness with time and temperature. The copper-aluminum system at equilibrium gives evidence of a number of intermediate "intermetallic compounds" identified by chemical formulae. The copper-rich constituent, and the aluminum-rich phase are both hard and brittle, and as they increase in thickness, account for the loss of ductility in the joint.

When aged at 215 C, for example, Knoop hardness of the diffusion layer under a 25 gram load ranged from about 600 to 900, while the hardness of the copper ranged from about 100 to 110, and the aluminum from about 40 to 50. The extreme increase in hardness upon mutual diffusion is responsible for the high brittleness of the alloy layer. This brittleness begins to affect the behavior of the transition joint when the alloy layer grows to a thickness of about 0.00004 in., and the joint is extremely brittle under impact when the layer reaches a thickness of 0.00009 in. A slight decrease in impact strength occurs after a service aging time of 4 days at 215 C, and almost complete loss of strength occurs after 28 days.

Effects of heating on the alloy layer are cumulative. One heating operation may be well below the safe time-temperature curve, while one or more subsequent heatings would carry the joint into the brittle region. Cooling the joint with water-soaked asbestos tape during heating operations is one practical means of retarding the growth of the brittle diffusion layer.

If embrittlement is to be avoided, specific time-temperature limitations must be placed on the service conditions for flash-welded copper-to-aluminum joints; yet, if these limitations are taken into account during design, manufacture, and operation, this method of joining copper to aluminum can be used to advantage and with dependability.

How to Prevent FATIGUE FAILURES

Practical, non-metallurgical discussion of causes for fatigue failures, such as surface finishes and coatings, fillets, temperature and corrosion. Design suggestions for increasing fatigue life of welded and riveted joints, and bolted connections.

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FATIGUE FAILURES are sudden fractures under repeated loads at stresses well below those which cause failure under static conditions. Metals are not perfectly homogeneous but consist of crystals with slip planes oriented in many directions. In repeated loading, crystals tend to slip back and forth on particular planes; the number of crystals slipping with each cycle is a function of the stress. At first, slippage may not be sufficient to cause damage; after many cycles the slipping surfaces tend to separate to form a small crack. Since the end of this crack is an area of concentrated stress, the crack tends to develop in a general direction at right angles to the tensile stress, gradually reducing the area of metal remaining in the cross section until fracture occurs.

Fatigue fractures usually show a progressive smooth area starting at the stress-raiser where concentric markings originate, and a rougher area with a bright crystalline structure. The progressive part of the fracture shows a burnished effect which is a result of the faces of the crack rubbing together. Rubbing of two surfaces may be accompanied by discoloration caused by grease or oxidation, particularly when long periods of service are involved.

Crack Propagation

Time elapsing between first detection of the crack and fracture of the part is an important consideration. Once a crack is formed, rate of growth depends upon intensity of stress, size of part and nature of the material. The crack may develop slowly over a period of years with different rates of growth depending on the stress level. After the crack starts it may require an additional 10 to 40 per cent of load cycles to cause failure. Cracks may develop during the early part of the life of a part because of occasional and abnormally high stresses. Normal service stresses may be so far below the high loads that caused the crack that failure is long delayed or perhaps never occurs during the life of the part.

Fatigue strength decreases as the stress range is increased. A reversed stress, from tension to compression, is the most destructive. As the stress range is reduced, loading approaches static conditions and fatigue strength becomes less important than static strength.

Causes of Fatigue Failure

In most cases failure is caused by poor design or faulty workmanship rather than in the selection of material. Abrupt changes in section, notches, fillets, holes, keyways, grooves, rough surfaces, and corrosion pits are potential sources. A notch concentrates stress and thus lowers fatigue strength; only one small surface imperfection repeatedly stressed above the fatigue limit is needed to start a crack. Fatigue failures may occur as a result of undetected injury during machining or from file marks, scratches, center punch marks, inspection or identification stamps, corrosion pits and rough edges around holes, keyways and grooves.

Harmful effects of stress raisers increase as the hardness of steel increases, particularly for sharp notches such as threads. Holes are frequent causes of stress concentration, especially when they have sharp edges. Oil holes are particularly dangerous since a small hole in a large plate under tension can produce a 3:1 stress concentration. In one study radial oil holes reduced the fatigue limit of a shaft from 55,000 psi (solid) to as low as 25,000 psi,

Opinions expressed are those of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

MOST FAILURES ARE CAUSED BY POOR DESIGN or faulty workmanship rather than by selection of material. This fatigue failure in a splined connection was the result of a loose fit; repeated peening action scored a longitudinal mark in the side of one spline (arrow) which became the starting point for a crack. Under continued loading the crack grew until finally the remaining section could no longer support the load.

depending upon the size of the hole and diameter of shaft.

Vee notches are more harmful than square notches. In one test, the fatigue limit of a smooth specimen was reduced from 48,000 psi to 23,000 psi by a square notch, and to 18,000 psi for a vee notch. Shallow notches or cracks, extremely sharp at the roots, are more critical than deeper and more rounded notches.

A series of notches has less effect than a single notch of the same size and shape. A part which is threaded throughout its length is stronger in fatigue than a part containing a single thread. A series of poor fillets or notches is more weakening in large parts than in small ones. Thus, a large part should be designed and finished with more care than a small one.

Stress concentration at a fillet is a function of fillet radius and relative sections of the adjoining parts; a larger fillet radius has greater resistance to fatigue failure. For a dras-

tic change in cross section, stress concentration may be reduced as much as 20 per cent by using an elliptical instead of a circular fillet.

Effect of Surface Finish

Smooth specimens have a higher fatigue limit than rough specimens. The effect of roughness on fatigue life is difficult to measure since the ordinary methods of evaluating surface roughness do not take into account the type of surface irregularities. A ground surface may appear to be smoother than a machined surface but fine scratches left by abraisive grit may be sharper than those left by the machine tool.

Direction of the surface notches is important; even smooth appearing tool marks and grinding scratches are dangerous when at right angles to the stress; irregularities however coarse are relatively harmless if the stress is parallel to the notches. For example, a lap or seam in a rolled bar may be of little importance if the stock is used for a bolt loaded in tension or shear. If the same bar stock is used for a part subject to repeated torsion, as in a helical spring, the notch could be a serious weakness.

The final cut on a turned surface may produce a relatively rough finish which can reduce the fatigue strength of parts. In one instance, polishing the surface of a rough-turned part increased the fatigue limit from 42,000 to 51,000 psi. Fatigue strength of an extruded aircraft tubing was increased from 47,000 psi to 57,000 psi by polishing out the extruding die marks.

In grinding, fatigue strength can be reduced by fine cracks resulting from overheating. Shot and grit blasting leave rough surfaces which may reduce fatigue life. Corroded or etched sufaces are particularly damaging.

Surface Treatments Affect Fatigue

A metal surface coating may affect fatigue strength even though the coating may produce a surface which is less notch sensitive or more corrosion resistant than the base metal. With a surface treatment developing a high fatigue strength a fatigue crack may develop at the boundry of the hardened surface and the softer underlying material, and then progress outward to the surface.

Cold working, carburizing, nitriding and cyaniding have a beneficial effect upon the fatigue strength of steel parts. Relative roughness of the surface is of less importance than the effect of residual stress induced by the treatments. A carburized surface is brittle and notch sensitive, and rapid cooling in heat treatment may introduce fine cracks at stress raisers such as notches, fillets and keyways.

Shot peened surfaces are roughened by the process but the cold working hardens and therefore strengthens the surface. The surface layer undergoes plastic deformation placing the surface in high initial compression and the core in relatively low tensile stress. When working stresses impose a tensile stress on the surface, the external load is offset by the residual compressive stress on the surface, resulting in considerably greater fatigue life. Shot peening will not increase the fatigue strength of a part subjected to axial loading, but it is helpful for parts under bending or torsion where stress is maximum at the surface. It can be most effectively applied to parts of irregular shape where heat treatment may cause excessive distortion, and where cold rolling or cold drawing is not feasible.

Decarburized surfaces have a weakening effect upon fatigue strength, even for decarburized layer only 0.001 in. deep, for a small crack can more readily form in the weaker surface layer where the stress is the greatest. Surface finish irregularities usually associated with decarburization such as small pits may also greatly reduce the fatigue strength.

Nitriding improves fatigue characteristics since the surface is left with residual compressive stresses better able to resist repeated tension loads. A fatigue fracture in nitrided parts usually starts beneath the surface, at or near the junction of the case and the core. Fatigue limit is unaffected by surface finish for unnotched or moderately notched specimens. Nitriding is superior to other forms of surface hardening because the surface layer has higher physical properties, sets up higher internal compressive stresses and is less notch-sensitive.

Surface Coatings

Metallic coatings generally reduce the fatigue strength of steel parts. Chromium plating reduces the bending fatigue strength of steel by 10 to 40 per cent; and the effect of nickel plating is equally severe. Major causes are fine cracks and residual tensile stresses in the coatings and hydrogen embrittlement in the base metal. A softer metal may be plated under chromium to hinder the spread of the fine cracks to the base metal.

Softer electroplated metals such as zinc, lead or copper have little effect on the fatigue strength of parts subjected to dry air. Under exposure to fresh water such plating increases the fatigue life.

The is little data on the effect of cadmium plating on the fatigue strength of steel; available evidence, indicates that the effect is not severe.

On aluminum the effect of bright nickel is to increase the fatigue strength; for 75S-T6 aluminum alloy, for example, tests at the Naval Air Station showed that the bending fatigue strength of 20,000 psi (at 250 million cycles) for the unplated alloy was increased to 28,000 psi for bright nickel; for a hard chromium plate the fatigue strength was reduced to 14,000 psi. Cladding 75S-T6 aluminum alloy with softer and more corrosion resistant pure aluminum reduced the fatigue strength from 20,000 psi (at 500 million cycles) to 12,500 psi. Scratches in the soft pure aluminum cladding are less detrimental than scratches on the alloy material.

Compared to zinc electroplating, hot dip galvanizing may reduce the fatigue strength of steel by amounts up to 40 per cent. This is caused by diffusion of molten zinc into the steel forming a rough brittle layer of zinc-iron alloy beneth the surface which tends to enlarge any existing defects. Parts subjected to repeated stress should not be zinc coated by the hot dip process.

Effect of Corrosion

Surface irregularities produced by corrosion occurring prior to application of stress are dangerous stress raisers. The detrimental effect is even more severe when repeated

stress and corrosion occur simultaneously; the combination of stress and corrosion in fresh water, can reduce the fatigue strength of steel by half. Cyclic stresses tend to break down protective coatings formed by reaction of the metal and the corroding agent. Corrosion is accelerated and the corroded surface acts as a large area of stress raisers to increase the rate of damage. The amount of corrosion visible is usually very slight; the damage is caused by sharp pitting rather than the reduction in area.

Steels have no definite fatigue limit under corrosive conditions. The attack is continuous and the fatigue limit continues to decrease with time. Therefore, no corrodible metal can last indefinitely under a corrosion-fatigue environment, no matter how small the repeated stress.

Inclusions

Influence of non-metallic inclusions on fatigue strength depends on their size, shape, number and distribution. Small globular inclusions have no significant effect, long inclusions arranged in random pattern can be damaging. Longitudinal inclusions, parallel to the direction of the stress, are harmless but become dangerous when stress is applied at right angles. The stress raising effects of such inclusions are not as harmful as cracks or deep seams.

Speed of Loading

Frequency of load application is unimportant at speeds under 30,000 repetitions per minute. At higher rates of loading, most materials become hot; if the fatigue strength is influenced by temperature, it will thus be affected by high loading speeds. Low-frequency cycles are more damaging than high-frequency when stress is accompanied by corrosion since the exposure time is the important factor.

Size and Geometric Factors

Smaller specimens usually show higher fatigue limits than larger ones. The effect of size has been clearly demonstrated by tests on railroad axles. A fatigue strength of 33,000 psi for a 0.3 in. diameter shaft was reduced to 28,000 psi for 1.5 in. diameter, and 17,500 psi for a 6.5 in. diameter shaft.

Notch factor increases with size. A large, hard piece is more likely to be affected by notches and poor finish. Statistically, there is more chance for failure with greater amounts of material exposed to peak stresses.

Effect of Temperature

Most metals have a higher fatigue strength at low temperatures and lower fatigue strength at elevated temperatures. There are, however, certain steels that show an increase in tensile strength with moderate increase in temperature followed by a decrease at higher temperatures. Frequency of loading, aging effects and metallurgical instability are all factors; fatigue strength of metals at elevated temperatures cannot be predicted without specific tests under simulated service conditions. It is held by some investigators that even though the fatigue strength may be greater, it is the creep strength that controls service life at elevated temperatures.

Table I—Fatigue Ratio for Spot Welds

Ratio of fatigue strength at 8 million cycles to static strength for 0.050 sheet.

Material	Seam Weld	Spotweld
RC70 Titanium	0.127	0.077
Type 302 Stainless	0.132	0.124
Clad 24S-T3 Aluminum	0.119	0.175

Joining Methods

Stress concentrations in welded joints can reduce the fatigue limit as much as 75 per cent, even though the static strength of the weld is unaffected. Rough welded surfaces, undercutting the parent metal by melting, slag particles, incomplete penetration, lack of fusion, porosity, unwelded seams, thermal or shrinkage cracks and shrinkage stresses are all harmful in fatigue. For best fatigue properties beads in butt joints should be ground down to the surface of the parent metal and corner beads should be ground to a radius.

Defects in spot and seam welds in the center portion of a weld where stresses are low have no detrimental effect on the fatigue strength. Around the perimeter of spot welds combined stresses are high, and failure generally begins there rather than at voids at the center.

Tests of spot welds in 0.050 in. titanium, stainless steel and aluminum evaluated at the Naval Air Experimental Station showed low fatigue in relation to static strength, as summarized in Table I.

Riveted joints reduce fatigue strength to 15 to 60 per cent of the static strength, depending on the type of rivet, material in sheet and rivet, and degree of control of the riveting process. Punched holes tend to produce rough surfaces which result in lower fatigue strength. Drilled holes with edges bevelled and cold worked minimize loss of strength. Open holes and idle rivets reduce the fatigue strength of riveted joints, the effect being greater with the open hole. Hot driven rivets reduce fatigue strength more than cold driven rivets.

Little specific information is available concerning the fatigue properties of riveted joints, except for the data developed by the aircraft industry on aluminum joints. Butt riveted aluminum joints and stiffened lap joints have higher fatigue strength than simple lap joints when riveted with standard button-head rivets, even though there is relatively little difference in static strength. With machined countersunk holes, lap and butt joints have nearly equal strength under static loads, but lap joints are superior under fatigue loads. Flush riveted joints using dimpled holes have greater strength than those using machined countersunk holes, under both static and fatigue loads. Fatigue strength of lap joints is higher with cold driven rivets than with hot driven rivets; the difference in strength is even greater when steel rivets are used.

Bolted Joints

Fatigue strength of a bolt is affected by the material, thread form, method of fabricating threads and forming of heads, surface condition and the amout of torque used for tightening. Fatigue failures in bolts usually occur

through the threaded section of the bolt at the first thread inside the nut, which is the weakest point since most of the load is carried by the first few threads. Rounding the root of the thread gives an appreciable improvement in resistance to fatigue failure. A comparison of the Whitworth thread with rounded root and the US Standard thread is shown in Table II for two materials.

Table II—Notch Factor for Threads

Ratio of fatigue strength of material before and after threading

Thread	Medium Carbon Steel	SAE 2320
Whitworth	1.76	3.32
U. S. Standard	2.84	3.85

Reverse tapering of screw threads may increase the fatigue strength by equalizing the load distribution over the first few threads. The runout angle of the first thread should not exceeed 15 deg for maximum fatigue strength. Increased elasticity of the bolt will increase the fatigue strength of the bolt, but increased elasticity of bolted members or anything which reduces the rigidity of the bolted assembly is harmful. Longer bolts thus have higher fatigue strength and washers and gaskets are fatigue hazards.

While static and bending strengths of rolled, ground, and machined threads are practically the same, the rolled screw thread offers the greatest fatigue strength. Rolled threads are up to 35 per cent stronger than cut threads; ground threads are usually better than cut threads.

Fatigue resistance may be improved by rolling thread roots, shot peening shanks or rolling the fillets between heads and shanks. The rolling operation hardens the surface and induces initial compression, both of which are beneficial. For hardened bolts rolling must be done after heat treatment.

Bolt heads should be hot or cold forged with a generous fillet under the head particularly under bending due to eccentric loading. In recent tests on 5/16 in. aluminum bolts at the Naval Air Experimental Station, fatigue life at 8 million cycles was increased from 400 lb to 950 lb by machining a fillet under the head. The fillet radius should be not less than 0.8d for small bolts and 0.1d for $\frac{3}{4}$ in. bolts and larger. Effect of bolt material on fatigue strength is shown in Table III, as determined from an investigation at the Naval Air Experimental Station. Minimum thickness of the nut for good fatigue life is 0.8d, and the nut material should have a lower modulus of elasticity than the bolt material.

Fatigue life of a bolt in a rigid assembly increases as the bolt is progressively tightened. Preloading reduces the amplitude of the stress range and thus increases fatigue life, provided that the bolted material is rigid.

Table III—Fatigue Ratio for Bolts

Ratio of fatigue strength at 8 million cycles to static strength for 5/16 in. bolts.

Material	Fatigue Ratio
Titanium Alloy	0.226
Steel	0.224
Steel (high strength)	0.330
Stainless Steel	0.254
Aluminum	0.098

Effect of Prestressing

Considerable strengthening of steel can be produced by repeated understressing just below the fatigue limit for several million cycles, followed by additional repeated stressing at small increases in load. By this method of "coaxing," the life of an annealed specimen at 40,000 psi working stress was increased from 12,500 cycles to 42 million cycles. An improvement in some steel parts has also been found by repeated overstressing just above the fatigue limit for a few cycles. Continued oversteress, however, will result in permanent damage if continued until a crack has formed.

Magnesium, aluminum and clad aluminum are damaged by any prestress above the damage line. Periods of rest between periods of loading have no effect on life; effects of fatigue loading are cumulative and metals do not recover from any damage during rest.

BACKGROUND—Because problems of endurance life are so common in design, a continuing editorial program has sought out and published the following significant contributions in recent issues.

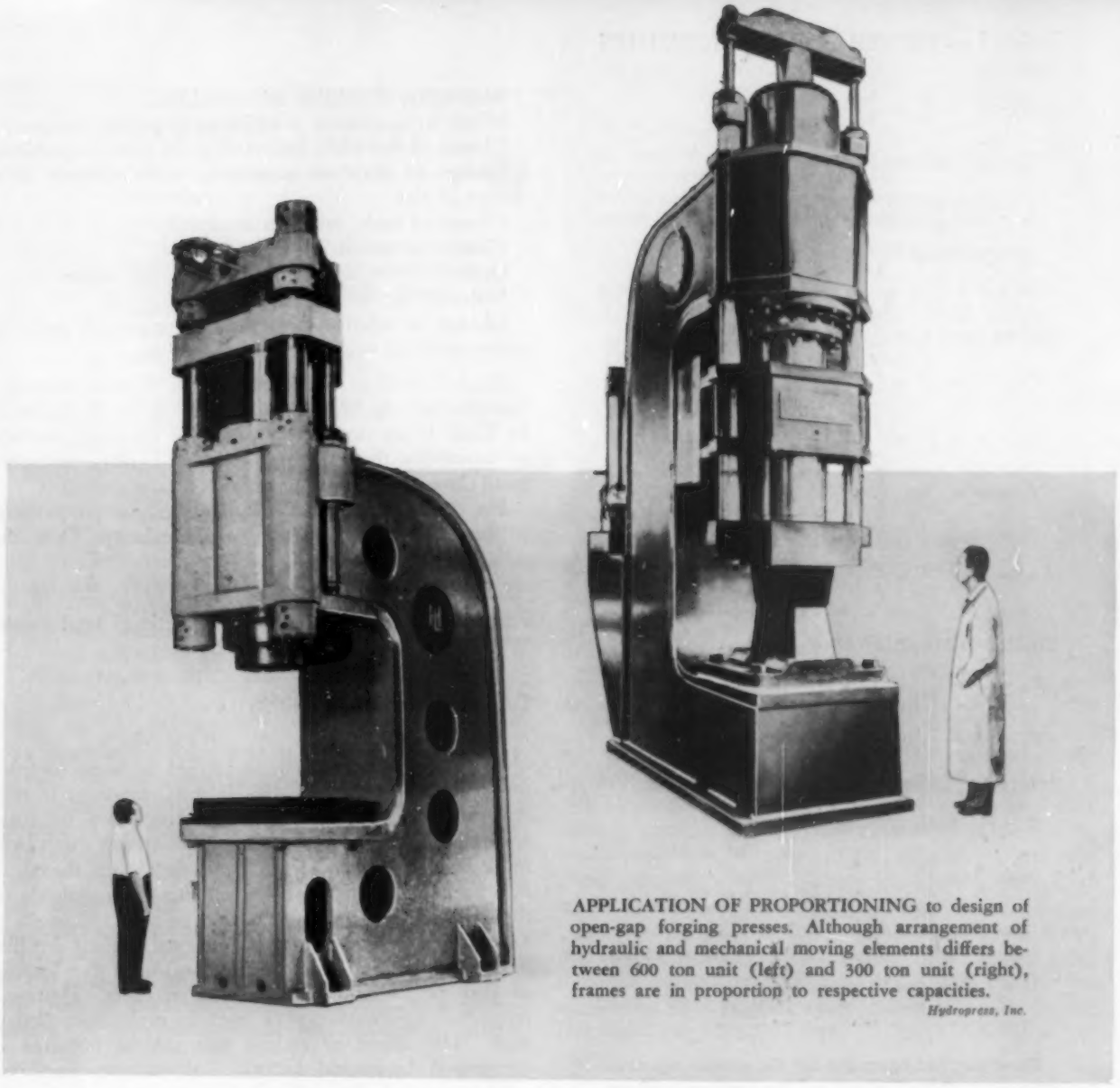
"Why Parts Fail," in August 1954 page 129, includes twelve typical case histories selected from a wide variety of problems presented to the National Bureau of Standards for analysis. Most of the examples are fatigue failures; a detailed discussion of the cause of failure is presented for each example.

A short article "Predicting Fatigue Failures of Notched Specimens," April 1955 page 177, suggests that stress raisers may be more readily understood if considered as strain raisers.

Fatigue testing methods are discussed in considerable detail in a series of two articles in 1953, "Fatigue Testing—Its Machines and Methods," February page 128, and March page 148. Practical considerations are stressed, along with a discussion of the types and operating principles for both single-purpose and universal testing machines.

Recent issues of the Annual Handbook have also included reference data on endurance strength. The forthcoming 1956 issue, has an important reference, "Fatigue Characteristics of Spring Materials," starting on page F-10. See also the 1955 issue, "Fatigue Strength of Welded Butt Joints in Aluminum Alloy Plates," page B-6; and "Fatigue and Static Tests of Flush-Riveted Joints," page G-2.

Other articles appearing in earlier years can be found from the annual index bound in the December issue each year. A notable series in 1949, later included in a text book, remains one of the most thorough and detailed discussions published. This series, "Significant Strength of Steels in the Design of Machine Parts," appeared in April page 142, May page 124, June page 179, July page 130, and August page 86. The textbook which incorporated this material, "Stress and Strength of Manufactured Parts," by C. Lipson, G. C. Noll and L. S. Clock, was published by McGraw-Hill in 1950.



APPLICATION OF PROPORTIONING to design of open-gap forging presses. Although arrangement of hydraulic and mechanical moving elements differs between 600 ton unit (left) and 300 ton unit (right), frames are in proportion to respective capacities.
Hydropress, Inc.

Designing by Proportion

Series of ratios for strength and rigidity useful as a time saving guide when designing larger or smaller units or assemblies based on a proven design.

WILLIAM GOVAN, Chief Project Engineer, Hydropress, Inc.

WHEN A NEW MACHINE OR COMPONENT is to be designed and data are available for similar units already in production, these data can be used as follows:

1. As a guide only for general appearance and functional details. All strength and rigidity calculations are reworked completely for the new design.

2. Original stress calculations applied almost exclusively to new design even though comparatively large discrepancies between the calculated and actual stresses might be introduced. Approximate correction factors may be added to account for major revisions such as changes in material or parts that field experiences have proved to be overdesigned or marginal.

3. New design can be proportioned mathematically from the previous design by applying a series of ratios —but without completely recalculating the stresses. These ratios are so chosen that the stresses in the new design are equal to the previous values, or are modified to suit

Table I — GENERAL RELATIONSHIPS

LINEAR

$$n = \frac{b_2}{b_1} = \frac{t_2}{t_1} = \frac{h_2}{h_1} = \frac{d_2}{d_1}$$

$L_n = \frac{L_2}{L_1}$ (not necessarily equal to n)

$b_n = n = \frac{b_2}{b_1}$ (where b represents any or all linear cross-sectional dimensions)

$k_n = n = \frac{k_2}{k_1} = \sqrt{\frac{I_2}{A_2}\frac{A_1}{I_1}}$ (ratio of radii of gyration)

CROSS-SECTIONAL

$$A_n = n^2 = \frac{A_2}{A_1} = \left(\frac{b_2}{b_1}\right)^2 = \frac{b_2 h_2}{b_1 h_1}$$

$$Z_n = n^3 = \frac{Z_2}{Z_1} = \frac{I_2}{c_2}\frac{c_1}{I_1} = \frac{b_2}{b_1}\left(\frac{h_2}{h_1}\right)^2 = \left(\frac{b_2}{b_1}\right)^3$$

$$I_n = n^4 = \frac{I_2}{I_1} = \frac{b_2}{b_1}\left(\frac{h_2}{h_1}\right)^3 = \left(\frac{b_2}{b_1}\right)^4$$

$J_n = n^4$

$w_n = n^2 = \frac{w_2}{w_1} = \frac{\rho_2 A_2}{\rho_1 A_1}$ (ratio of weights per unit length)

THREE-DIMENSIONAL ($L_n = n$)

$$V'_n = n^3 = \frac{V'_2}{V'_1} = \left(\frac{b_2}{b_1}\right)^3 = \frac{b_2 h_2 L_2}{b_1 h_1 L_1}$$

$W_n = n^3 = \frac{W_2}{W_1} = \frac{\rho_2 V'_2}{\rho_1 V'_1}$ (ratio of total weights)

LOADS, STRESSES, DEFLECTIONS

$F_n = \frac{F_2}{F_1}$ (ratio of loads)

$$s_n = \frac{s_2}{s_1} = \frac{(s_{ult})_2 (N_1)}{(N_2)(s_{ult})_1} = \frac{(s_{yp})_2 (N'_1)}{(N'_2)(s_{yp})_1}$$

$y = \frac{e}{L}$ and $a = \frac{\theta}{L}$

$T = F(e)$

$M = CFL = CwL^2$ (where $wL = F$)

$$y = \frac{e}{L} = \frac{KFL^2}{LEI} = \frac{KFL^2}{EI} = \frac{KwL^3}{EI}$$

These last two equations are the general equations for a beam where C and K are the coefficients of moment and deflection respectively and take into account the load pattern, continuity over supports, fixity of supports, cantilever effects. These coefficients are assumed to be unchanged for the old and the new design.

The load pattern is the relative positions, directions, magnitudes, and linear lengths of application of a series of concentrated or uniformly distributed loads on a beam or other member. Load patterns must be the same for the old and the new design.

Cross sections of the old and the new design must be geometrically similar in the linear ratio n.

the new conditions. This method is basically the same as the one noted under (2) but incorporates several short-cuts and should introduce fewer discrepancies.

The number as well as the values of these ratios will be determined by the differences between the new and old designs. Among the many possibilities that may be involved are:

Existing part of sub-assembly used on a new machine.

Regrouping of existing sub-assemblies.

Minor improvements or additions to existing design.

Change of size while maintaining the same proportions.

Change of shape or proportion, with relatively little change of size.

Change of loads, pressures or capacity.

Change of speeds.

Quality, life expectancy or factor of safety differ.

Materials and working stresses are changed.

Change of relative strengths of component parts to correct previous weaknesses or over-design.

General relations usually needed to develop ratios for strength and rigidity calculations are given in Table I. In Table II are derived the ratios for members, sections or assemblies that are geometrically similar, preferably in all three dimensions but at least in cross section.

For these conditions, the load capacity is proportional to the square of the linear ratio of similarity. Thus, the ratio of load capacities F_n is

$$F_n = n^2 \quad \text{or} \quad n = \sqrt{F_n}$$

For three-dimensional similarity, the ratio of total weight W_n is

$$W_n = n^3 = F_n n \quad \text{or} \quad W_n = (F_n)^{3/2}$$

For two-dimensional similarity

$$W_n = n^2 L_n \quad \text{or} \quad W_n = F_n L_n$$

The same approach can be applied to more complex formulas but, in general, this is not necessary. If new designs are proportioned from existing ones by basic equations, the use of a more complicated formula will make little difference to the proportions even though it may be more accurate for determining the magnitude of the stresses.

Some parts should never be designed entirely by this method, unless it is impossible to calculate the loading so that proportioning is the only recourse. However, proportioning always can be used in preliminary design work. The degree of success that can be obtained is determined by several factors. For example, parts involving one of the following must be handled with discretion:

1. Velocity factor. An allowance can be incorporated in the ratios by modifying the ratio of stresses in the new and the old designs to compensate for a difference in velocities.

2. Standard, code, empirical or tabulated methods. This includes such parts as belts, chains, gears, anti-friction bearings, sleeve bearings (these include velocity factors), also springs, wire rope, pressure vessels.

3. Parts designed entirely, or in part, on some basis other than strength or rigidity, such as appearance, wear, corrosion, electrical, magnetic or thermal properties. For example, an arbitrary increase, say $\frac{1}{8}$ in., may be made in the thickness of sheet steel for outdoor use to allow for rust or corrosion. In designing a larger part, the total thickness of the original design should not be used in proportioning. Rather the basic thickness—before the allowance is added—should be multiplied by the ratio factor and the $\frac{1}{8}$ in. added to the result.

4. Limited number of standard or stock sizes are available, such as bolts, and in some cases, plate thicknesses. If a larger size was used in the original design than

NOMENCLATURE

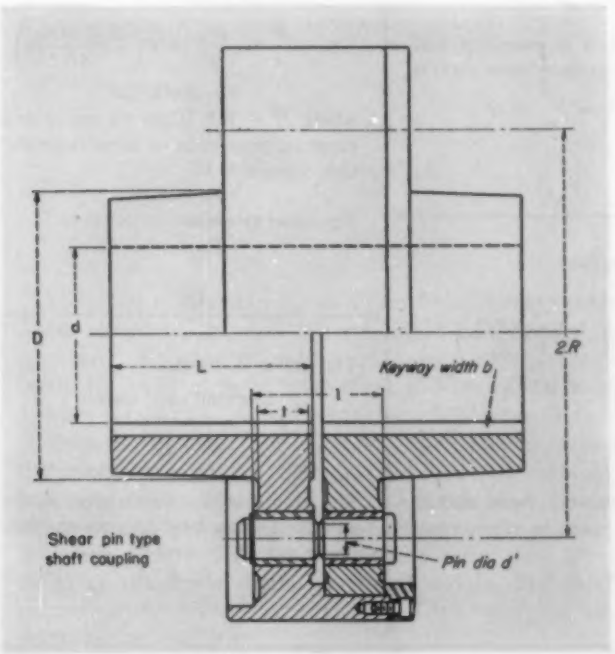
a	angular deflection per unit length, or unit angular deflection	L	total length or span
A	area	M	moment
b	breadth, width or any or all linear dimensions	n	ratio of new design to old design
c	distance from neutral axis to extreme fiber	N	factor of safety based on ultimate strength
C	coefficient of moment in beam formula, or any constant	N'	factor of safety based on yield point
C', C''	constants	p	normal load per unit area; pressure
d	inner or smaller dia	q	any number
D	outer or larger dia	r	inner or smaller radius
e	eccentricity or moment arm	R	outer or larger radius; radius of curvature of a beam
E	modulus of elasticity	s	stress (particularly tensile stress)
F	force, or system of forces	t	thickness
G	modulus of elasticity in shear (torsion)	T	torque
h	height	V	shear force on a beam
I	moment of inertia	V'	volume
J	polar moment of inertia	w	uniformly distributed load or weight per unit length
k	radius of gyration	W	total weight
K	stress concentration factor, or coefficient of deflection in beam formula, or any constant	y	elongation or deflection per unit length or per unit span; unit deflection
K', K''	constants	Z	section modulus
l	constant proportion of total length or span	ρ	density or weight per unit volume
		ϵ	total elongation or deflection
		θ	total angular deflection

actually needed for strength because the next smaller standard size was considered marginal, a similar size step-up made when proportioning the new design may mean the part in the new design will be several sizes larger than needed. For example, mild steel bolts smaller than $\frac{1}{2}$ in. are rarely used in heavy machinery regardless of the load. Smaller bolts could not withstand the assembly techniques and handling that such equipment gets. Thus, a new machine with twice the load may well be able to use the same size bolt.

5. Multiple loads which cause cumulative or combined stresses. In such instances the load pattern or relationship between the magnitudes of the various loads is not the same for the new and old designs.

6. Cross sectional shape or relative proportions that must be changed for functional reasons. For example, it may be necessary to make a beam, such as the bed of a press, relatively wider in comparison to its depth and length than it was in the original design.

It is often possible to derive additional ratios, not given in Table II, to suit particular needs. Also one can apply them not only to the dimensions of the parts, but also to the loading when this is a function of size, speed, acceleration, inertia or pressure.



EXAMPLE 1—Design of shear-pin shaft coupling

(a) Shear of shaft (case 8)

$$F_n = n^2$$

(b) Shear of key

$$s_s = \frac{Fe}{\frac{1}{2}dbL} \qquad F_n = (s_s)_n \frac{dbL}{e_n} = (s_s)_n n^2$$

For equal stresses

$$F_n = n^2$$

(c) Shear of pins

$$s_s = \frac{Fe}{RqA} \qquad F_n = \frac{(s_s)_n R_n A_n}{e_n} = (s_s)_n n^2$$

For equal ultimate stresses

$$F_n = n^2$$

(d) Bending of pins

$$s = \left(\frac{Fe}{Rq}\right)\left(\frac{Cl}{Z}\right)$$

$$F_n = \frac{S_n R_n Z_n}{e_n l_n} = s_n n^2$$

Table II—Ratios for Strength and Rigidity Equations

1. Direct Stress

Since average tension and compression stresses ($s = F/A$) and shear stresses in beams ($S_s = V/A_{web}$) are independent of length

$$F_n = s_n A_n = s_n n^2$$

For equal stresses in new and old designs

$$F_n = n^2$$

or

$$n = \sqrt{F_n}$$

2. Elongation or Deflection

Unit deflection, y, can be written

$$y = \frac{\epsilon}{L} = \frac{FL}{LAE} = \frac{F}{AE}$$

Therefore,

$$F_n = y_n A_n E_n$$

If unit deflection and modulus of elasticity is same in new and old design

$$F_n = n^2$$

3. Torsion

Moment arms are assumed to be in same linear ratio n as other dimensions

Since $T = Fe$

$$F_n = T_n/e_n = T_n/n$$

Also

$$S_s = Tc/J = T/Z_p \quad \text{(round section)}$$

$$T_n = (S_s)_n (Z_p)_n = (S_s)_n n^3$$

For equal stresses

$$F_n = n^2 = \sqrt[3]{(T_n)^2}$$

4. Cylinders

Thin wall

$$S = pD/2t$$

$$p_n = S_n t_n / D_n = S_n$$

Thick wall

$$S = p\,\frac{D^2 + d^2}{D^2 - d^2}$$

$$p_n = S_n$$

External pressure

$$S = p\,\frac{2D^2}{D^2 - d^2}$$

$$p_n = S_n$$

For equal pressures

$$F_n = p_n n^3 = n^2$$

5. Flexure of Beams

Moment arms assumed to be in same linear ratio n as the beams

$$S = Mc/I = M/Z$$

$$S_n = M_n/Z_n$$

For equal stresses

$$M_n = n^3$$

For couple

$$M = Fe = C'FL \quad \text{where} \quad e = C'L$$

For concentrated load

$$M = CFL$$

Thus for spans in same linear ratio n,

$$S = CFL/Z$$

and

$$F_n = S_n Z_n / L_n = S_n n^3$$

For equal stresses

$$F_n = n^3$$

For uniformly distributed load

$$F = pbl = wl = C''wL$$

and

$$p_n = F_n/b_n l_n = n^2/n^2 = \text{unity}$$

Also

$$w_n = F_n/l_n = n$$

Thus for condition $F_n = n^2$ loads per unit area are same in new and old design and loads per unit length are in ratio n.

6. Radius of Curvature

(Corresponding to case 5)

$$R = EI/M$$

Thus

$$M_n = \frac{E_n I_n}{R_n} = \frac{n^4}{R_n}$$

$$M_n = \frac{n^4}{n} = n^3$$

For equal moduli of elasticity and radii of curvature in same linear ratio n

$$F_n = \frac{M_n}{l_n} = \frac{n^3}{n} = n^2$$

7. Linear Deflection

(Corresponding to case 5)

$$y = \frac{\epsilon}{L} = \left(\frac{1}{L}\right)\left(\frac{KFL^3}{EI}\right)$$

$$y = \left(\frac{1}{L}\right)\left(\frac{K'ML^2}{EI}\right)$$

$$M_n = \frac{y_n E_n I_n}{L_n} = n^3$$

For equal unit deflections, equal moduli of elasticity, and spans in same linear ratio n

$$F_n = M_n/n = n^2$$

8. Shafts—ASME Code

$$S_s = \frac{16}{\pi D^3}\left[(K_t T)^2 + (K_m M)^2\right]^{1/2}$$

$M = CFL$ and $T = F'e = C'FL$ where e is assumed to be a constant proportion of L and forces F and F' are in constant ratio

$$S_s = \frac{16}{\pi D^3}\left[(K'FL)^2 + (K''FL)^2\right]^{1/2}$$

$$S_s = KFL/D^3$$

$$F_n = (S_s)_n D_n^3 / L_n = (S_s)_n n^2$$

For equal stresses and lengths in constant ratio n

$$F_n = n^2$$

9. Combined Shear and Torsion

$$(S_s)_{max} = \tfrac{1}{2}S_t + \left[(S_s)^2 + \tfrac{1}{4}(S_t)^2\right]^{1/2}$$

$$= \frac{F}{2A} + \left[\left(\frac{2KF}{2A}\right)^2 + \left(\frac{F}{2A}\right)^2\right]^{1/2}$$

$$= \frac{F}{2A}\left(1 + \sqrt{4K^2 + 1}\right)$$

$$F_n = S_n A = S_n n^2$$

For equal stresses

$$F_n = n^2$$

Thus if forces in new and old design are in constant proportion, relationship for simple stress (Case 1) also applies to combined stress.

10. Combined Axial Load and Moment

$$S = \frac{F}{A} + \frac{F'e}{Z} = F\left(\frac{Z + KAe}{AZ}\right)$$

$$S = Fb^3 K'/b^4$$

where $F' = KF$ (Case 8) and e is a constant proportion of linear cross section dimension b.

$$F_n = S_n n^2$$

For equal stresses

$$F_n = n^2$$

11. Euler Column

Limiting axial load is

$$F = \frac{C\pi^2 EAk^2}{L^2}$$

$$F_n = A_n (k_n)^2 / (L_n)^2$$

For equal moduli of elasticity, similar end conditions, and lengths in same linear ratio n

$$F_n = n^2$$

12. Torsional Deflection

$$T = Fe$$
$$F_n = T_n/e_n = T_n/n$$
$$a = \theta/L = TL/LGJ$$

Therefore

$$T_n = a_n G_n J_n$$

For equal unit deflections and equal shear moduli

$$T_n = n^4$$

Also

$$F_n = a_n G_n J_n/e_n$$

For equal unit deflections and equal shear moduli

$$F_n = n^3$$

Note: This is the only case where $F_n = n^3$ for strength but not for deflection.

13. Flexure of Beams—I

(For beams with geometrically similar cross sections in ratio n but in different spans, carrying equal loads.)

$$S = CFL/Z$$
$$Z_n = F_n L_n/S_n$$

Since F_n = unity

$$S_n = L_n/n^3$$

For equal stresses

$$n^3 = L_n = L_2/L_1$$
$$w_n = L_n A_n = n^5$$

14. Beam Deflection

(Corresponding to Case 13)

$$y = \frac{e}{L} = \frac{KFL^3}{LEZ}$$

$$w_n = \frac{F_n L_n)^3}{y_n E_n}$$

For equal unit deflections, equal loads and equal moduli of elasticity

$$I_n = (L_n)^3$$
$$n^4 = (L_n)^3 \quad \text{or} \quad n = \sqrt{L_n}$$

15. Flexure of Beams—II

(For beams with geometrically similar cross sections in linear ratio n, with different spans and carrying different total loads. Load patterns—relative positions and relative magnitudes of a series of loads—must be the same).

From Case 13,

$$n^3 = F_n L_n/S_n$$

For equal stresses

$$n^3 = F_n L_n$$
$$= F_2 L_2/F_1 L_1$$
$$w_n = L_n A_n = n^6/F_n$$

16. Flexure of Beams—III

Flexure on beams of different spans, carrying uniformly distributed loads of equal magnitude per unit length. Load patterns must be the same, and beams geometrically similar cross sections in linear ratio n.

$$s = \frac{C' w 1 L}{Z} = \frac{C w L^3}{Z}$$

$$Z_n = \frac{w_n (L_n)^3}{s_n}$$

For equal stresses,

$$n^3 = \frac{(L_n)^3}{s_n} = (L_n)^3$$
$$n = \sqrt[3]{(L_n)^3}$$
$$W_n = L_n A_n = \sqrt{n^5 \cdot n^2}$$
$$= \sqrt{n^7} = \sqrt[3]{(L_n)^7}$$

17. Flexure of Beams—IV

For beams of different spans carrying their own dead weight, or carrying uniformly distributed loads per unit length such that ratio of unit loads equals ratio of beam cross sectional areas ($w_n = n^2$). Load patterns must be same and cross sections in linear ratio n.

$$Z_n = w_n(L_n)^3/S_n$$
$$n^3 = n^2(L_n)^3/S_n$$

For equal stresses

$$n = (L_n)^3$$
$$w_n = L_n A_n = \sqrt{n}\, n^3 = \sqrt{n^5} = (L_n)^5$$

If $L_n = n$

$$S_n = n, \quad \text{and} \quad F = n^3$$

Note: Beam webs in Table II must be checked for shear by method of Table II—Case 1.

For equal stresses

$$F_n = n^3$$

(e) Weber shear (at junction with hub)

$$S_s = \frac{Fe}{\frac{1}{2} D\pi\, Dt}$$

$$F_n = \frac{(S_s)_n t_n D_n^2}{e_n} = (S_s)_n n^2$$

For equal stresses

$$F_n = n^3$$

Thus, the relationship $F_n = n^3$ can be applied to complete assemblies as well as individual components if geometric similarity is maintained, even though indeterminate loads, stress concentrations and unequal sharing of loads is involved. Also, the equations for torque instead of force can be used. For instance, Table III summarizes the calculations for an assembly similar to this example, but using torque instead of force. Stresses in most elements of the new design were increased by 5 per cent to reduce weight. However, since the shear pins often failed at stresses less than the rated values, the shear stresses on the reduced cross section of the new pins was decreased by 3 per cent.

Table III—Calculations for Shear Pin Coupling

	Original	Ratio Factor	New
Torque, in.-lb	500,000	1.25	625,000
Stresses, general	s	1.05	$1.05 \times s$
Linear ratio	.....	1.06*	
Weight, lb	1,300	1.19	=1,550
Width of key, in.	2	1.06	2.12
Depth of key, in.	1 3/8	1.06	1.46
Dia of shaft, in.	8 5/8	1.06	9.15
Dia of hub, in.	14	1.06	14.83
Length of hub, in.	10	1.06	10.60
Thickness of web, in.	2 1/2	1.06	2.65
Number of pins	2	1.00	2
OD of pins, in.	2	1.06	2.12
Length of bushings for pins, in.	3	1.06	3.18
OD of flange, in.	28 1/4	1.06	29.95
Dia of pitch circle of pins, in.	20	1.06	21.20
Force at pitch circle	50,000	1.178**	58,900
Breaking stress	s_s	0.97	$0.97 s_s$
Linear ratio for root dia of pin	.....	1.102***	
Root dia of pin, in.	1.125	1.102	2.40

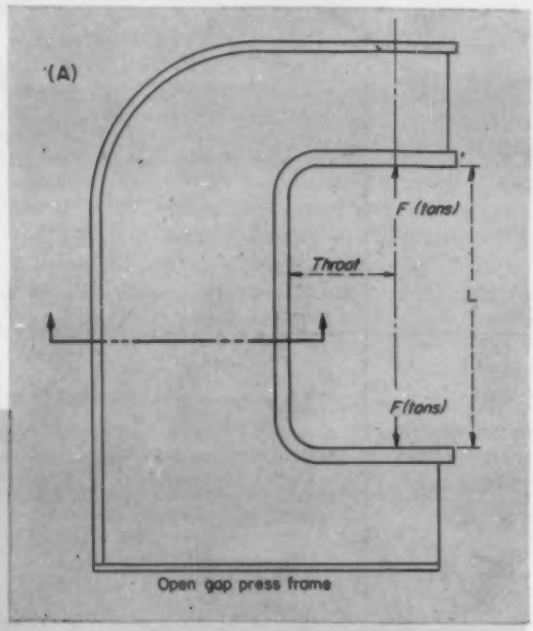
* $1.06 = \left(\frac{1.25}{1.05}\right)^{1/3}$ ** $1.178 = 1.25/1.06$

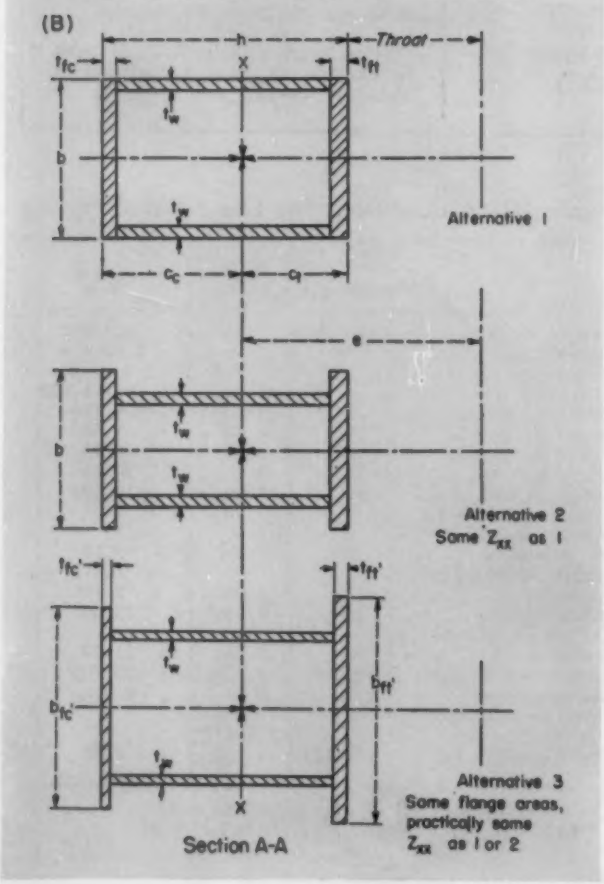
*** $1.102 = \sqrt{1.178/0.97}$

EXAMPLE 2–Open gap press frame (Table II–Case 10)

These frames are illustrated below. Note that the height of the opening L has no effect on the stresses and need not be in proportion in most instances. However, it has an effect on the deflection, and should be in proportion if this is critical.

Geometrically similar sections can be distorted within certain limits, as shown at (B), without reducing their ability to resist direct stress or bending in one plane. Thus alternative 2 shows that the webs may be relocated anywhere between the flanges with limits determined by flange buckling. Alternative 3 shows that the flanges may be altered as long as the net flange area is kept constant, that is $(b_f - 2t_w)\ t_f$, there will be little change in section modulus. Hence, the technique of design by proportion can be used for a preliminary solution, and modified for the final design.





Data for this design are listed in Table IV. The first column gives the basic figures for the original 600 ton press. The second column lists the data for a geometrically similar 150 ton press. The third column is the same press, but with the flanges widened and thinned as an alternative 3. In the fourth column, a 125 ton press with relatively greater eccentricity is tabulated. The section is the same as in column 2, direct stress is slightly lower, bending moment slightly higher, combined stress almost the same. Obviously, the greater eccentricity has complicated the problem. Proportional design can be used in the first steps of the solution, but if accuracy is critical, a more involved analysis is necessary in the final stages.

Table IV—Press Calculations

Press Tonnage, F	600	150	150	125
Throat, in.	38	19	19	27¼
Eccentricity, e, in.	63.7	31.8	31.7	40.1
Moment, in-tons	38,200	4,770	4,770	5,010
Depth, h, in.	60	30	30	30
Width Tension Flange, b_{ft}, in.	40	20	23½	20
Thickness, t_{ft}, in.	6	3	2½	3
Width Compress. Flange, b_{fc}, in.	40	20	21⅝	20
Thickness, t_{fc}, in.	3	1½	1⅜	1½
Web, t_w, in.	2½	1¼	1¼	1¼
Ratio, n	1	½	½	½
n^2	1	¼	¼	¼
n^3	1	⅛	⅛	⅛
Net Flange Area Tension in.^{2}	210	52.5	52.5	52.5
Net Flange Area Compression, in.^{2}	105	26.2	26.2	26.2
Webs Area Gross	300	75.0	75.0	75.0
Total Area	615	153.7	153.7	153.7
c_t, in.	25.65	12.82	12.75	12.82
c_c, in.	34.35	17.18	17.25	17.18
Section Modulus for Tension	12,380	1,545	1,580	1,545
Direct Stress, psi	1,950	1,950	1,950	1,625
Flexural Tension, psi	6,170	6,170	6,030	6,485
Combined Tension, psi	8,120	8,120	7,980	8,110

EDITOR'S NOTE—In addition to the applications cited in the article, the technique of designing by proportion is useful when loads or shape make a rigorous stress analysis impossible. Often both the analyst, with methods theoretically 100 per cent accurate, and the rule-of-thumb designer, whose formula may be only 75 per cent accurate, must make the same basic assumption—which may double the stresses whether calculated by theoretical or empirical methods.

Also, there are other size effects that must be considered. This was pointed out in "Effects of Size on Gear Design Calculations," by Paul M. Dean, Jr., April 1954, page 129. In his article Mr. Dean discussed influence on center distance, accuracy of angular transmission, contact ratio and how tolerances contribute to the scale-effect.

Mercury Jet Switch

Motor-driven jet samples 120 circuits in fixed sequence at a commutating rate of 7200 items per sec. Both sampling rate and number of circuits commutated can be varied. Switch is free from contact bounce and has a contact resistance of only 1.4 ohms, thousands of hours operation without servicing.

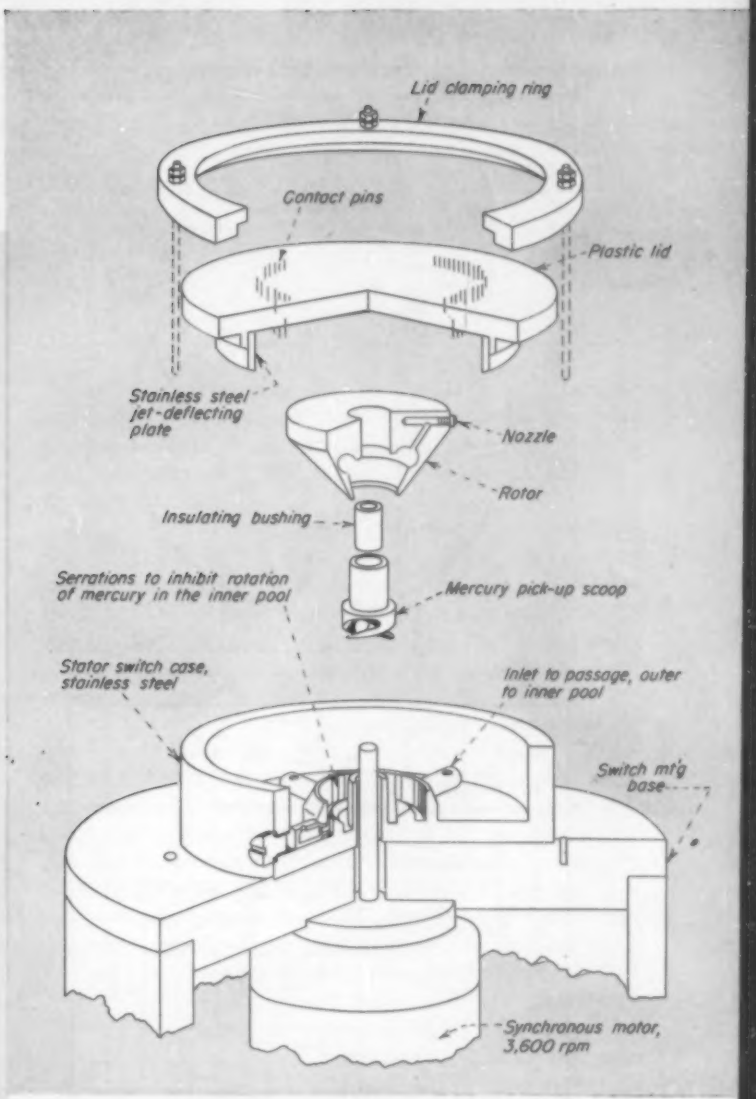


Fig. 1—In the mercury jet switch, an electrical circuit is completed when a stream of mercury impinges stainless steel contact pins. Rotation of nozzle sweeps the stream past circle of pins, using mercury as pole-to-contact connection.

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COMMUTATING SELECTOR SWITCHES have been standard system components since the early development of what is now termed telemetering. As systems have progressed, requirements have demanded that larger numbers of circuits be monitored at progressively smaller time intervals. This has resulted in commutators sampling 60 to 100 circuits and rotating up to 2000 rpm. Higher sampling speeds using standard mechanical commutators have met with limited success because of short contact life and contact bounce inherent in spring-loaded rubbing contacts.

One method which has successfully overcome these difficulties utilizes a jet stream of conducting liquid, such as mercury, as the pole-to-contact connection in a rotary switch. This type switch is not new and was mentioned in a patent as early as 1899. (See references at end of article.) Functionally, the rotary jet switch is a single-pole multiple-contact selector switch which differs from mechanical commutators in that it must be rotating in order to provide transmission. The switch described here can be driven at least to 10,000 rpm.

Basically, the switch consists of a centrifugal pump primed by a screw-type scoop shown in Fig. 1. This lifts mercury from a sump into an annular rotating pool from which it is ejected by centrifugal force in a stream through a small nozzle. The jet of mercury impinges upon a series of stainless-steel contact pins located outside the periphery of the rotor, and then returns to the sump by gravity, completing the mercury cycle.

During the time the jet stream is in contact with one of the steel pins, a low-resistance electrical contact exists through the mercury between the pin and the sump into which a pole contact is inserted. Mercury in the jet stream is ejected at a speed of approximately 63 fps, under a pres-

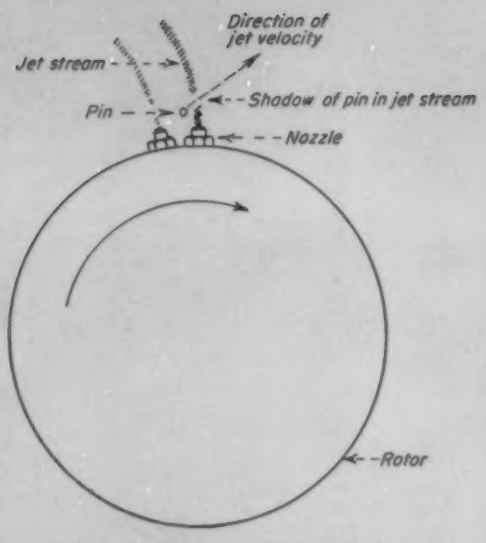


Fig. 2—As rotor spins, mercury jet stream curves under the combined effect of tangential and radial velocities.

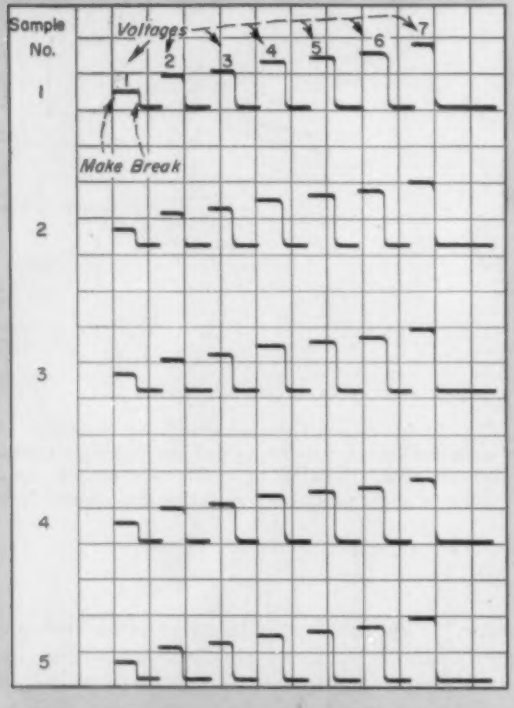


Fig. 5—Oscillograph record of several changing voltages being monitored simultaneously on five pins.

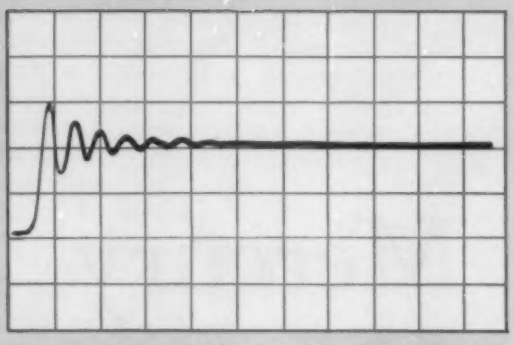


Fig. 3—Contact-make rise time. Transient variation of voltage as contact makes is due to inductance of switch leads. Intial contact was made in 0.05 microsec and voltage settled to final value at 0.8 microsec. Sweep speed in this record was 0.2 microsec per division.

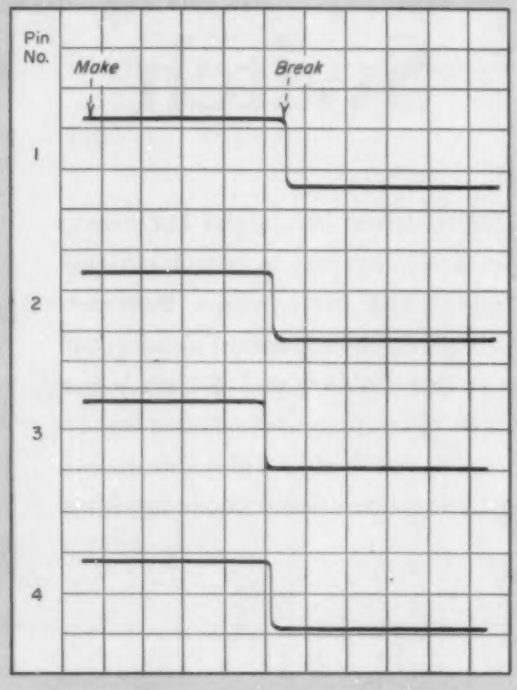


Fig. 4—Complete make-dwell break cycles for four successive contacts. Make time is so rapid that initial trace is not apparent. Break time is longer than make; variation in time at which break occurs is indicated by random shifts to right of central reference axis. This jitter presents no switching problem. Sweep speed in this record is 10 microsec per division.

sure drop across the nozzle of about 300 psi. The direction of the velocity of the mercury is a little more than 45 deg from radial, having a radial component that is only slightly less than the tangential component. The latter is equal to the peripheral velocity of the rotor at the instant the mercury leaves the nozzle. The mercury path is curved in nature and trails the nozzle as shown in Fig. 2.

The jet switches are composed of three basic components—a case, a rotor, and a lid containing the contact pins. Best results have been obtained with a case and rotor of metal, as shown in Fig. 1. The lid contains 240 stainless steel pins equally spaced on a 3-in. diameter pin circle and cast into an epoxy resin. This arrangement results in pin spacing of 0.039 in. center-to-center. The pins are 0.014 in. in diameter, leaving a gap of 0.025 in. between.

Switching Characteristics

Characteristics important in any commutator for telemetering operations are: (1) switching transients and noise level, (2) dwell time of the pole on each contact, (3)

contact resistance, (4) current-carrying capacity and limiting voltage levels, and (5) switching speeds.

Electrical noise observed in jet switches constructed to date is of two kinds. The first is due to a variation in contact-break time and is described in the next paragraph. The second is due to the discharge of static electricity generated during operation of the switch. The exact nature of this discharge depends upon the electrical characteristics of the load between the main pole and the numerous pins. If the pole is terminated with a 10,000-ohm resistor, the switch with metal rotor and case produces about one discharge per minute with a duration of about one microsecond and at a negligible potential of approximately 0.5 volts.

Dwell time is that period during which the mercury jet maintains contact between the main pole and one of the pins. The voltage change as the jet stream comes in contact with a pin having a d-c potential of 6 volts is shown by the oscilloscope trace in Fig. 3. The voltage rises in 0.05 microsec to the final value, "rings" for a few cycles at about a 7 megacycle rate, and settles down after about 0.8 microsec. This "ringing" is due to inductance of the connecting wires and is not inherent in initiating the contact.

A complete period of dwell time is shown in Fig. 4. The sweep speed used to obtain this pattern (10 microsec per cm) was considerably slower than the previous one. The "make" occurs at the far left and the speed of contact is too fast to produce a plainly visible trace. The "break" at the end of dwell time is several times longer than the "make", and the vertical "break" trace is visible in the center of the illustration. Although each of the four traces rises at the left at exactly the same place the duration of each pulse is slightly different due to variation in the "break" time. This uncertainty in "break" time is possibly due to a slight vibration of the pin caused by the impinging mercury stream. The deviation is sufficiently small to present no particular problem in any mode of operation attempted so far.

Table I

Orifice Diameter (inch)	Time On (microseconds)	Time Off (microseconds)	Dwell Time (per cent)
0.003	40	100	28.5
0.004	60	80	42.8
0.005	70	70	50.0
0.006	75	65	53.5
0.007	80	60	57.0

Length of the dwell period is an important consideration. Duration of the actual dwell time can be varied by merely changing the speed at which the switch is driven. Control of percentage of dwell time can be conveniently and effectively obtained by varying the diameter of the jet stream. Table I shows the effect of orifice sizes on dwell time.

This test set-up used a lid containing 120 pins, all of which were connected. When the nozzle orifice was increased to 0.008 in. bridging or "make-before-break" operation occurred between adjacent pins. This apparent discontinuity (a jump from 57 per cent to 100 per cent dwell) was due to the fact that some of the mercury in the jet, on hitting a given pin, was redirected toward the next pin in the circle, momentarily bridging the gap before the main jet arrived. This problem was overcome by using 240 pins but connecting only alternate ones. With 120 "floating" pins in the lid, an orifice of 0.0105 in. did not cause bridging of adjacent circuits, and resulted in a contact having 120 microsec on and 20 off for an 86 per cent dwell. This technique is expected to produce dwell times of about 100 per cent.

With the switch driven by a synchronous motor at 60 rps and a switch lid containing 240 pins with alternate pins "live", 120 circuits can be monitored per revolution. With this switch arrangement the mercury jet requires 140 microsec to travel between corresponding portions of adjacent pins or circuits. Fig. 5 shows a series of d-c voltages being monitored on successive circuits 1 through 5. The on time was about 74 microsec and the off time about 66 microsec, or a dwell of about 55 per cent.

Contact resistance of the switch is of the order of 1.4 ohms.

Current capacity depends on the combination of volt-

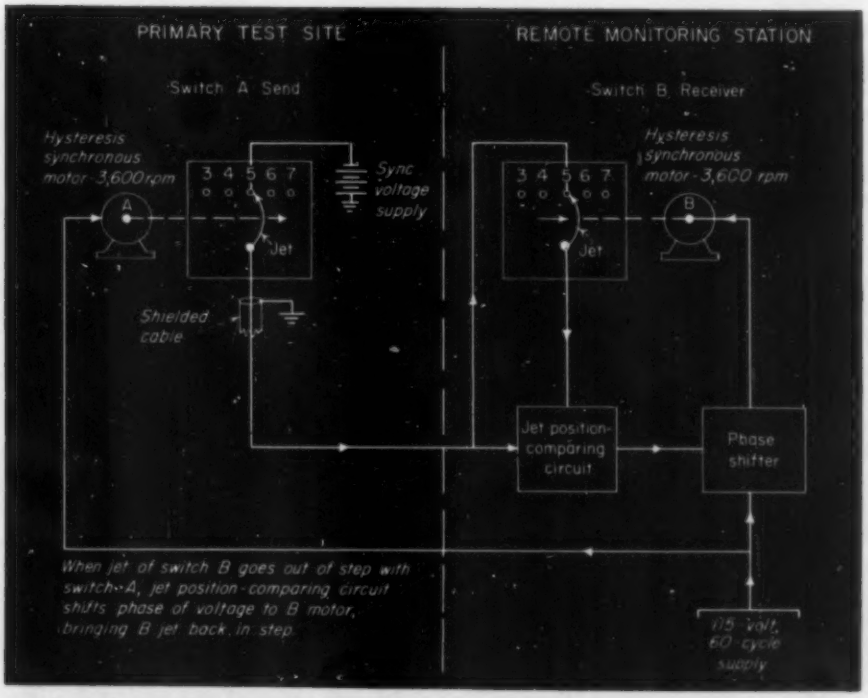

PRIMARY TEST SITE
REMOTE MONITORING STATION
Switch A Send
Switch B Receiver
Hysteresis synchronous motor-3,600rpm
Sync voltage supply
Hysteresis synchronous motor-3,600 rpm
3 4 5 6 7
Jet
A
B
Shielded cable
Jet position-comparing circuit
Phase shifter
When jet of switch B goes out of step with switch-A, jet position-comparing circuit shifts phase of voltage to B motor, bringing B jet back in step
115-volt, 60-cycle supply

Fig. 6—Basic synchronizing system for two mercury jet switches used in monitoring more than a hundred circuits over a single pair of wires. Shield of cable is one conductor.

age and current, and pin spacing. With all pins "live", arcing occurred when attempting to switch 125 volts at 62.5 ma into a 2000-ohm load; to prevent arcing, alternate pins had to be removed. With all pins in place no arcing occurred when higher currents were interrupted at lower voltage levels, and higher voltages were monitored at lower current levels. For example a current of 150 ma was interrupted at 1.5 volts applied to 10 ohms. Similarly, 15 ma flowing in a 20,000-ohm load caused no arcing when interrupting 300 volts. Thus, by varying pin spacing and choosing the proper circuit load, a considerable range of currents or voltages can be interrupted.

Rotational speeds for most of the tests were 3600 rpm but the per cent dwell remained unchanged at speeds from 1800 to 10,000 rpm (fastest drive available). By suitable design of the scoop mechanism that primes the centrifugal pump, or by delivering the mercury to the pool in the rotor by some other method, a much greater speed range can apparently be achieved.

Synchronizing System for Telemetering

A primary application of the mercury jet switch is relaying information from about 100 circuits at a primary test site to a remote monitoring station, using but one pair of wires. Two identical switches are used, one at each location as shown in the block diagram of Fig. 6. The switch rotors are turned at 3600 rpm by hyteresis synchronous motors supplied from the same 115-volt, 60-cycle source. To keep both rotors exactly in step a synchronizing (sync) voltage is applied to pin 5 of switch A which is chosen as the reference. This sync voltage from switch A at the primary test site is compared with another voltage from pin 5 on switch B, located at the monitoring station. If these voltages do not coincide, a corrective signal is developed which changes the phase of the voltage applied to motor B until it locks in synchronism with motor A.

Developmental work on this switch was sponsored by the University of California Radiation Laboratory. The author wishes to express his appreciation to Mr. H. R. Hulett and Dr. E. J. Wilson, Jr. for many helpful contributions.

REFERENCES

The idea of using a stream of liquid such as mercury as a conductor is not new, as shown by these U. S. Patents: Hans Boas, No. 625,921, May 30, 1899; R. H. Cunningham, No. 688,-068, December 3, 1901; August R. Luschka, No. 690,973; dated January 14, 1902; M. H. W. Widakowich, No. 2,444,687, July 6, 1948; A. L. Holcomb, No. 2,609,461, September 2, 1952.

Design and construction of a mercury jet switch was undertaken at the Navy Electronics Laboratory in San Diego, and reported by H. Nathan in Report No. 297, "Rotary-Jet Mercury Switching Technique," in ASTIA No. 159839, June 9, 1952. A similar project on temperature monitoring was reported by R. Hoff in a paper "The Mercury Jet Switch and Its Applications," read before the Instrument Society in Cleveland in September 1952.

Additional background information on static electricity mentioned under "Electrical Noise," may be found in: E. E. Dodd, "The Statistics of Liquid Spray and Dust Electrification," *Institute of Physics*, 1953; P. Lenard, *Ann. Physik*, 47, p 463, 1915; L. B. Loeb, *Science*, 102, p 573, 1945; R. L. Lyon, *Liquid-Metals Handbook*, A. E. C., Dept of Navy, Washington, D. C., June 1, 1950; C. C. Miesse, "Correlation of Experimental Data on the Disintegration of Liquid Jets," Paper No. 88-53, A. R. S.

High-Density Tape for Digital Computers

AN ASSET TO ELECTRONIC COMPUTER OPERATION is a new method for closely packing digital pulses on magnetic tape. Developed by the data processing laboratory of the National Bureau of Standards, this high-density storage can materially reduce problem solution time by providing more rapid access to information recorded on external magnetic tape units. In a series of experiments, both continuous-current and pulse techniques were investigated to achieve densities in the range of 500 to 700 pulses per inch. Recording and reading circuitry was also developed to give large amplitude playback signals with error-free differentiation between binary "ones" and "zeroes".

In solving many types of mathematical problems, relatively little actual computation is done, but a great deal of data must be handled and assimilated by the computer. Ideally, the magnetic tape system would supply or receive data fast enough so that the computer could proceed with the problem solution at a normal rate. Actually, the maximum rate at which such information can be handled by the tape unit is very slow compared to the speed of the machine due to tape speed limitations and low density at which information is commonly stored on the tape. As a result, most of the problem solution time is spent not in computation, but in the performance of input-output, or tape storage operations.

In testing one variation of the non-return-to-zero system of tape recording, NBS used a digital pulse technique instead of the continuous current method to get tape magnetization. To record a binary "one" with the pulse technique, a pulse of opposite polarity to the previous pulse is recorded. To record a binary "zero", a pulse of the same polarity as the previous one is recorded. So, on playback, there is a single voltage swing for each recorded "one", and no voltage for a "zero".

To find the maximum usable pulse density, a number of recordings were made. For each recording the tape speed was held constant, the pulse duration was two microseconds, and the pulse current 60 ma. The only parameter that was changed was the pulse repetition rate, which was increased on successive recordings, crowding the pulses closer together. When the recordings were read back, it was found that the playback voltage increased with pulse density until a maximum of 440 pulses per in. was reached. The voltage then began to decrease for greater densities, but so slowly that even at 730 pulses per in., the output signal amplitude was still usable.

The new storage system has been given extensive trials to determine reliability of reading and recording circuitry at different recording densities. Without taking precautions to prevent errors from tape flaws, runs of one to three million digits were recorded and read at densities of 500 to 600 digits per in. without apparent errors.

How to Set Up a Material Specification System

Basic content of a company specification.
Use of National standards and recommended practices.
Suggestions for a numbering system and index, format and distribution.
A check list and method of periodic review.

PLANNING A SPECIFICATION

In preparing specifications, planning is a necessity. Details not handled properly ultimately become major problems. Here is the order in which such details should be considered:

1. Numbering system.
2. Specification format and method of duplication.
3. Index and method of preparation.
4. Method for distribution of information.
5. Check sheet.
6. Adequate record file.
7. Trade name file.
8. System of periodic review.

JOSEPH GURSKI
Manufacturing Research Department, Ford Motor Company

THE CONTENT OF A SPECIFICATION is the most important single thing about any system of company specifications. Other factors are of importance in that they influence the physical work of a specification activity, and minimize much confusion. However, the requirements of the specification itself are vital, since they determine the cost of the material being purchased, its suitability for processing, and finally its serviceability.

The basic thinking in the choice of materials for a product should be to select the least expensive material that will do the intended job. Anything else is economically wasteful of both money and material. Obviously, the inclusion in a specification of requirements which serve no useful purpose should be discouraged. Similarly, to restrict the range of requirements is also wasteful. For one thing it will increase the cost of acceptance inspection. More important, it may restrict the number of suppliers, thereby lessening competition and certainly adding to the cost of the material, because the supplier must exercise greater care or be subject to rejections.

In setting up a system, the following five main headings may be used: 1. Scope; 2. Application; 3. Requirements; 4. Approval of Suppliers; 5. General Information.

The "Scope" contains a complete, but preferably, non technical description of the desired material.

The "Application" describes where the material is generally used, or under what conditions it is to be used. This is not a basic requirement of a specification, but is a concession to expediency. This section may not stay correct as new uses may be found; however it does give an indication of application.

The "Requirements" list the mandatory attributes needed to control the quality of the material. They contain realistic limits consistent with typical manufacturing tolerances.

"Approval" describes the conditions under which new suppliers receive certification. This paragraph indicates whether a simple laboratory test is adequate, or whether shop trials are needed.

"General Information" headings are used to list such things as typical analyses, annealing procedures, or method of specifying on part prints.

Fig. 1 shows a typical specification with the above headings mentioned.

NATIONAL STANDARDS

The use of national standards is always desirable. Specifying bodies such as the Society of Automotive Engineers, American Society for Testing Materials, American Standards Association and others develop specifications which are recognized throughout industry, and through wide usage make the purchasing of materials relatively easy.

At the author's company such specifications are used when possible—particularly SAE specifications, because some of the company personnel were on the committees which developed them.

In some cases specifications as developed by other specifying bodies do not adequately describe the materials that a company will use. In such cases it is possible for a company to supplement the information issued by these national bodies, and build its specifications with their

MATERIAL SPECIFICATION

FORD MOTOR COMPANY

MFG ENGR JAN 54 2015

M 4B1

NITRATE HEAT TREAT SALT

1. SCOPE: The material desired under this specification is a heat treat salt consisting of a mixture of potassium nitrate (KNO_3) and sodium nitrate ($NaNO_3$) salts.

2. APPLICATION: The material shall be suitable for use for low temperature heat treating baths generally used in martempering, tempering, or austempering operations.

3. REQUIREMENTS:

3.1 Composition:

Potassium Nitrate (KNO_3)	50-60%
Sodium Nitrate ($NaNO_3$)	40-50%

3.2 Melting Point: 450 F maximum

3.3 Operating Range: 500 - 1000 F

3.4 Color: Salts shall be tinted red in a manner which will not harm the performance of the material.

3.5 Packaging: Material must be packaged in weather resistant and moisture proof containers.

3.6 Supplier's Responsibility: All material supplied to this specification must be equivalent in all characteristics to the material upon which approval was originally granted and shall be suitable for the intended application.

4. APPROVAL OF NEW SUPPLIERS: All new suppliers to this specification must be laboratory approved by the Divisional Quality Control Laboratory or Chemical Engineering Department for Divisional application or by the Quality Laboratory, Manufacturing Staff, for Company wide application. Recommendations for addition of suppliers to the approved list must be made in writing to the Manufacturing Research Department. Test data upon which the recommendations are based must be attached. This material must be given a Divisional shop trial. The shop trial and laboratory report must be approved by Manufacturing Research Department.

5. GENERAL INFORMATION:

5.1 Safety: Safety precautions must be followed as outlined in Process Specification MS 8-1.

5.1.1 Under no circumstances are CYANIDES to be allowed to come in contact with these highly oxidizing low temperature baths either as carry over from other heat treating operations or by direct addition.

Fig. 1—A Specification Sheet used at the author's company, listing the five main headings that are employed to completely define the part or material.

information as a nucleus. In addition, there are many materials for which specifications are not written, and probably never will be written by national bodies. In such cases, a company can develop its own information.

RECOMMENDED PRACTICES

While Recommended Practices do not strictly qualify as company specifications, nevertheless they have extremely important functions. Through the medium of recommended practices one can achieve standardization and simplification of materials. The SAE defines Recommended Practices as, "Recommendations based on sound engineering principles intended as guides for standard engineering practices." These recommended practices take a variety of shapes. However, they have one thing in common in that they establish some requirements of materials as a basis for their selection for various applications. These requirements may be dimensional, chemical, metallurgical, or any other which affect their suitability.

Recommended practices highlight the pertinent factors that should be considered in the selection of materials, and point out the need for an evaluation of new materials. These practices are difficult to develop in that it is desirable to develop simple Recommended Practices which can be understood by everyone. Fig. 2 shows a Recommended Practice developed for the Selection of Cutting Fluids.

NUMBERING SYSTEM AND INDEX

Numbering systems specifications can be compared with filing systems. If it is anticipated that a file will not grow beyond the stage of one cabinet, then no particular system is necessary. One could look at every piece of paper in

PROCESS SPECIFICATION

FORD MOTOR COMPANY

MFG ENGR JAN 54 2015a

RP 1-15

SELECTION OF CUTTING FLUIDS

The following charts list recommended coolants and cutting oils for various machining operations and materials when using high speed tool steels. Approved equivalent coolants may be substituted although the listed ones are preferred. For carbide tools, M-589-B Standard Soluble Oil, Petroleum Base is recommended in those instances where a coolant is desired. Use in a concentration that will keep corrosion at a minimum. Recommended dilutions are between 24:1 and 60:1.

The chart is to be read as follows: M-589-B, 24:1 means that M-589-B is mixed with water in the ratio of 24 parts of water to 1 part of oil; M-501 and M-4635-A, 5:1 means that 5 parts of M-501 are mixed with 1 part of M-4635-A. In those instances where two different fluids are given for the same operation on the same material, the top fluid is recommended and the second or bottom fluid is optional

FERROUS METALS

Type Of Material	Automatic Screw Machines	Boring, Milling, Profiling, Chucking	Broaching	Drilling	Gear Cutting	Gear Shaving	Hand Screw Machines & Lathes	Threading and Tapping	Honing	Grinding	Thread Grinding
Carbon Steels	M-3C5	M-589-B 24:1	M-501 and M-4635-A 5:1 ---or--- Sol. Oil*	M-589-B 24:1	M-3C5 ---or--- M-589-B** 24:1	M-3C3	M-589-B 24:1	M-3C5	M-4640-B	M-589-B 60:1 ---or--- M-3C6	M-4635-H
Alloy Steels	M-3C5	M-589-B 24:1	M-501 and M-4635-A 5:1 ---or--- Sol. Oil*	M-589-B 24:1	M-3C5 ---or--- M-589-B** 24:1	M-3C3	M-589-B 24:1	M-3C5	M-4640-B	M-589-B 60:1	M-4635-H
Stainless Steels	M-501 and M-4635-A 5:1	M-501 and M-4635-A 5:1 ---or--- Sol. Oil*	M-501 and M-4635-A 5:1	M-501 and M-4635-A 5:1 ---or--- Sol. Oil*	M-4635-H	M-3C3	M-3C5 ---or--- Sol. Oil*	M-3C3 ---or--- M-4635-H	M-4640-B	M-3C2 60:1	M-4635-H
Steel Castings		M-589-B 24:1	M-501 and M-4635-A 5:1 ---or--- Sol. Oil*	M-589-B 24:1	M-3C5 ---or--- M-589-B** 24:1	M-3C3	M-589-B 24:1	M-501 and M-4635-A 5:1	M-4640-B	M-589-B 60:1	M-4635-H
Cast Or Malleable Iron		M-589-B 24:1	M-589-B 24:1	M-589-B 24:1	M-3C4 40:1	M-4635-H	M-3C4 40:1	M-3C4 40:1	M-532-A-B ---or--- M-4640-B	M-3C4 40:1	M-4635-H

NON-FERROUS METALS

Aluminum	M-501 and M-4647-B 19:1	M-3C2 40:1	M-3C2 40:1	M-3C2 40:1	M-3C2 40:1	M-3C2 40:1	M-3C2 40:1	M-3C2 40:1	M-4640-B	M-3C2 40:1	M-3C2 40:1
Copper and Copper Alloys	M-501	M-589-B 40:1	M-589-B 24:1	M-589-B 40:1	M-501 ---or--- M-589-B** 24:1	M-589-B 24:1	M-589-B 40:1	M-501	M-532-A-B	M-589-B 60:1	M-501 and M-532
Magnesium	M-501	M-501 or Dry	M-3C5	M-501 or Dry	M-501	M-501 or CO_2	M-501	M-501	M-4640-B	M-501	M-501
Zinc		M-589-B 40:1	M-589-B 24:1	M-589-B 40:1	M-589-B 40:1	M-589-B 40:1	M-589-B 40:1	M-589-B 40:1	M-4640-B	M-589-B 60:1	M-589-B 60:1

* Consult divisional metallurgist.
** Only where construction of machine permits its use.

Fig. 2—Recommended practices do not exactly come under the heading of company specifications; however, they do serve as a guide to unify thinking on a particular subject and promote the use of standards.

order to find a particular item. When a file grows too large, this hit and miss method is no longer applicable, and some sort of system must be developed. So it is with a numbering system for specifications. As long as there is only a handful of specifications, any system such as 1, 2, 3, 4, etc., will do. When one can in time visualize hundreds or thousands of numbers, then some sort of system must be developed.

It is necessary to have some idea of the volume of specifications that will be involved before grouping related materials into some system. Obviously, groups with only a few specifications are no more desirable than file folders with only several sheets of paper. A system which carries a breakdown too far is almost as bad as no system at all.

An example of a coding system is shown in Fig. 3.

In the author's company the prefix letter "M" has had a long history as identification for a Material Specification. In order to continue with the prefix letter "M" and still use another letter to identify groups, numbers such as M-5B1 are used. In all cases "M" establishes the fact that a Material Specification is being discussed; the second letter, "B", denotes that the material is a chemical; the first digit, "5", denotes that the chemical is a washer and cleaner compound; and the second digit, "1", indicates the first of a series.

The use of a system such as illustrated in Fig. 3 does have a number of advantages. It tells anyone familiar with the system: the type of material involved; minimizes the chance of issuing numbers for very similar materials; groups like materials and aids in selection; and provides identification for an infinite number of specifications within the initially selected groups. Incidentally, once a specification has been obsoleted for some reason, the number should not be re-used even at some later date. References

INDEX TO MATERIAL SPECIFICATIONS CODING SYSTEM

MA—METALS
1. Ferrous, Misc.
2. Non-Ferrous, Misc.
3. Tool, Die & Equipment
4. Welding & Brazing Filler Metal
5. Spring Steel Wire
6. Electrical (Contact Points, Resistors, Bi-Metals)
7. Anodes
8. Bearing Metals
9. Shot-Grit
10. Powder

MB—CHEMICALS
1. Soaps
2. Plating Compounds
3. Conversion Coating Compounds
4. Heat Treating Compounds
5. Washer & Cleaner Compounds
8. Alcohol & Antifreeze
10. Metal Polishing Compounds
11. Organic Finish Polishing Compounds
12. Solid Fuels
13. Flux
14. Draw Compounds & Hot Die Lubricants
16. Acids
17. Gases
97. Organic, Other
98. Inorganic, Other
99. Miscellaneous

MC—PETROLEUM PRODUCTS
1. Lubricating Grease
2. Lubricating Oil
3. Machining Coolants
4. Liquid Fuels
6. Hydraulic Oils and Fluids
7. Rust Preventives
8. Multiple Purpose Oils
99. Miscellaneous

MD—RUBBER & PLASTICS
1. Friction Materials
2. Rubber
3. Thermo-Setting Plastics
4. Thermo-Plastic Plastics
97. Rubber Mfg. Materials
98. Plastics Mfg. Materials
99. Rubber & Plastics, Misc. (Excluding Gaskets)

ME—PAPER
1. Paper
2. Paper Boards
3. Pyroxylin or Vinyl Coated Boards
98. Paper Mfg. Materials

MF—LEATHER
1. Genuine Leather
2. Artificial Leather
3. Quilted Artificial Leather
98. Artificial Leather Mfg. Materials

MG—NON-METALLICS (Not Otherwise Listed)
1. Trim Bindings
2. Adhesives
3. Tapes, Adhesive
4. Sealers, Fillers
5. Mastic Sound Deadeners
6. Anti-Squeak
7. Refractories
8. Gaskets
9. Waxes
10. Asphalt, Tar, Pitch
11. Wood
12. Glass

MH—TEXTILES
1. Body
2. Sidewall Cloth
3. Carpet
4. Curtain & Top Cloth
5. Headlining
6. Seat Cover Material
7. Webbing
15. Threads
16. Felts
17. Padding

MJ—PAINTS
1. Air Dry Paint
2. Baking Enamel
25. Dual Purpose Baking Enamel
3. Polishing Enamel
31. Satin Polishing Enamel
4. Lacquer
41. Satin Polishing Lacquer
5. Maintenance Paint
6. Primers
7. Shellac, Varnish, Stains
10. Pigments
11. Resins
12. Enamel Mill Bases
13. Lacquer Mill Bases
14. Solvents and Thinners
98. Paint Mfg. Materials

ML—ELECTRICAL
1. Multiple Wire Assemblies
2. Single Wire
3. Insulating Material

MR—CASTING & STEEL MANUFACTURE PROCESSING MATERIALS (Other than fuels)
1. Ferrous Melting Metals
2. Non-Ferrous Melting Metals
3. Fluxes
4. Core & Mold Materials

Fig. 3—In an index such as this, the method by which it is made up is important, since frequent revisions will be necessary. Any method which requires only the retyping of those lines that need changing is desirable.

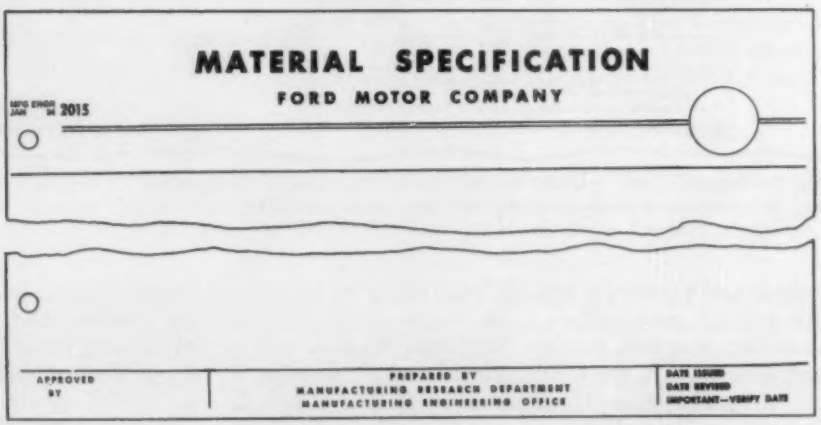


Fig. 4—Format of a specification shows company's name, and in this case that a material specification is contained. At bottom is the issuing department, and a space for approval. The ideal format uses a minimum of space, and leaves most of the room for information.

to specifications persist for remarkably long periods of time, particularly on product drawings. The use of a number of an obsoleted material as a designation for an entirely different material could result in complications. Also, care should be exercised in the initial selection of a numbering system, because changing a system once established could be very confusing, and result in costly engineering errors. The best indexing method, of course, is that which requires only the retyping of those lines that need changing.

FORMAT OF A SPECIFICATION

A format should be developed which will suit the purpose for which the specifications will be used. Fig. 4 shows an example of a format that has been found to be satisfactory.

The format clearly indicates the company's name, and that a Material Specification is the content. It has a prominent place for the title and identifying number. The bottom indicates the issuing department, and provides

space for specific approval. The space for issue and revisions is important, since dates are a prerequisite of any discussion to insure latest available information.

There are many things about the actual specification sheet that should be considered. Final decisions can be made only after all factors are weighed. Generally speaking, the least expensive method of accurate preparation and reproduction, consistent with desired speed and available manpower, is what all companies strive for. The appearance of the finished specification and the number of copies required influence the selector of typewriter and reproducing method. One thing that is not generally considered is the time consumed in retyping a specification to make a slight revision in one or two paragraphs. A photographic method of reproduction, changing only the affected paragraphs should be considered to reduce the work and produce a more accurate copy.

A format should be designed which uses a minimum of space and leaves most of the room for information. Printing should be done on both sides of the sheet to minimize the number of sheets to reduce collating costs.

DISTRIBUTION OF SPECIFICATION INFORMATION AND SPECIFICATIONS

To acquaint various departments in the company with the latest information on specifications, an Information Letter is usually circulated. This letter is sent out at approximately monthly intervals and lists the numbers assigned to new materials, indicates that certain specifications have been written or revised, and states that other specifications have been obsoleted. Such a Letter in effect, becomes a supplement to an Index.

New or revised specifications are not sent out with an Information Letter, because all areas of the company are not interested in every specification that is written. While this procedure results in some delay in getting information, it also eliminates the necessity of numerous receiving locations handling a tremendous volume of paper for which they have no use. Specifications are sent out immediately on request to speed up service as much as possible.

The Engineering Department's Materials Engineer must have available information on specifications in order to have an adequate selection of materials for particular applications. The Manufacturing Engineer and Chemical Engineer are interested in materials used for "non-production" applications, and must know what materials are available. Purchasing agents must have specifications available to them in order to buy materials properly. Also, they must have a supply of specifications on hand for vendors who are bidding. Quality Control Laboratories must have specifications available to them in order to test materials adequately, and to determine whether they meet all requirements.

SPECIFICATION CHECK SHEET

There are many facets to the problem of writing, issuing, and keeping specifications and specification references accurate. Without a formal check sheet, many details are overlooked, and before long it becomes a matter of continually correcting mistakes that are found, instead of a positive approach to prevent their occurrence.

Fig. 5 indicates the type of check sheet that has been found to be satisfactory. Basically, it indicates the items that are initiated by a specification activity and shows

SPECIFICATION CHECK SHEET

Name: _____ No.: _____

_____ Date: _____

Specified For: _____ Written By: _____

_____ Date Typed: _____

		1	2	3	4	5	6	7	8	9	10
"M" No Assigned		A	B	B	B	A	A	B			A
Revised "M" No.		A	B	B	B	A	A	B			A
Obsoleted "M" No.		A	B	B	B		A		B	B	A
New Specification		A	B		B	A	A	B	B		A
Revised Specification			B		B	A	A	B	B		A
Obsoleted Specification		A		B	B		A	B	B	B	A
RP Specification		A				A	A	A	A		A

Requested By: _____ Dept. _____ Engg Request No. _____

Request Filed With: _____ Flash Point: _____ Class: _____

Other Numbers Affected: _____

_____

Copies To: _____

_____

_____

_____

_____

CODE

1. Index
2. Trade Name File
3. Flash Point
4. Approved Suppliers' List
5. Periodic Review
6. Information Letter
7. Other Numbers Affected
8. Material & Process Handbook
9. Recommended Practice
10. File

Supplier: _____

Supplier's Designation: _____

Fig. 5—A formal check sheet like this keeps many of the details connected with specification writing from being overlooked. Primarily, it lists items of a particular specification group, and shows how each item affects other lists and records.

how each item affects other lists and records for which the specification group is responsible. For example, when a specification number is assigned, this action affects the index, a periodic review list, an information letter, and the file. It may or may not affect a trade name file, a listing of material flash points, an approved suppliers list, or other specifications. As the various items are done, the individual who does the job initials the appropriate box.

Similarly, revisions, obsoletions, and other items all have definite effects on the various records. By taking care of the details as soon as they occur, the possibilities of errors creeping into a system are minimized and information is kept current.

RECORDS

Adequate records play an important part of any specification function. At the time a number is assigned, detail records may seem like a nuisance because the information is fresh. However, if a specification exists for any length of time, the records will be referred to many times, and often three, four, and five years later. Such information as: who requested the material, where it is used, its chemical analysis, any physical tests that were run, any shop trials that were run, all becomes important. This is particularly true when comparisons have to be made to approve a second source. Consequently, the greater the number of specifications that are handled by a specification activity, the more complete such records must be.

TRADE NAME FILE

The consideration of a Trade Name File and a system of company specifications perhaps does not seem compatible. However, through the aggressive sales techniques of suppliers, brand names of various materials are constantly brought to the attention of users. The circulation of technical magazines with their materials advertising is constantly increasing; memberships in technical societies offer opportunities for personal contact to extoll virtues of materials; and active selling on the job all contribute to make the user aware of materials which could help him do a better job.

Consequently, since many of the materials referred for approval are generally described by a trade name or a supplier's code, it has been found necessary to keep such a file. With it, one can determine the kind of material it is, whether it has been investigated, and the purpose for which the material is intended. Also, it will tell whether or not the material has been approved for one of the specifications.

Many of the advertised materials are good, but they are similar and will do similar jobs. Consequently, when similar materials are approved to a specification the company gets the benefit of a certain amount of competition. Permitting the use of brand names would make it difficult to take advantage of either lower prices or new products.

PERIODIC REVIEW

One of the problems which arises in a specification activity is that of keeping up to date. Conditions change constantly, new materials are brought forth, errors were introduced into the original writing of the specification, and limits were too broad on certain requirements. These reasons and many others make it necessary to institute some method by which materials can be reviewed without creating a crisis that must be handled as an emergency.

As a specification number is assigned, it should be automatically listed for review at an appropriate interval. The interval may be six months, a year, or possibly two years, depending on the type of material and other circumstances. After it is reviewed, it should be relisted for another review at some later date.

APPROVAL OF SUPPLIERS

A specification's purpose has been defined as being "to insure a flow of uniform material." Accomplishing this purpose is relatively simple for many materials that are used in a company's operations. Those materials which can be readily described, and for which adequate inspection procedures can be employed, present no problem. Steels, non-ferrous metals, ferro-alloys, pig iron, lubricating oils and similar materials are in such a class. However, it is also true that many materials which are purchased to specification are difficult to describe exactly. Analyses are difficult to make, or if made, the results of the analyses are difficult to correlate with actual job performance.

In those cases, it is best to have suppliers who are familiar with the materials that one requires. A supplier who has furnished the material previously, generally has records which indicate to him that what he furnished was satisfactory for the intended application. Once it has been established that a specific supplier's material conforms to the specification, he is entered as an approved source.

The amount of work required to approve a supplier depends to a large extent on the detail requirements of the specification. If laboratory determinations are all that are required, the job is easy. When the specification requires that in addition a shop trial must be run, the situation is complicated.

PROCESS SPECIFICATIONS

So far, only Material Specifications have been discussed. Process specifications are a necessary adjunct to "company specifications." They can assume two forms.

One type describes what is desired in an end product without indicating exactly how that requirement is to be accomplished. This type of specification usually belongs on a part drawing. The reasoning behind this type of specification is that one does not tell a supplier what he wants and how to do it too. Either one or the other has to be specified. An example of this is a plating specification in which is indicated a thickness of coating and other requirements such as salt spray resistance, color, resistance to peeling, etc. A supplier is not told how to apply the plating, and such a responsibility is left to him.

Another type of Process Specification describes how chemical or metallurgical processes are carried out. It establishes sequence of operations, times, and temperatures. Materials required in the processing are indicated, since it is obvious that even acceptable materials can be improperly used with results that leave much to be desired.

This type of specification is used to insure uniformity of operations from day to day, and as a check point to indicate any deviations from operations which have proven satisfactory in the past.

Sealed Electrical Terminals

When a large number of electrical leads must be brought inside a sealed compartment, pressure-tight panels simplify design and installation. Here are two applications—a cold test chamber, and a shipboard control device.

Pressure-Tight Connections for Cold Chamber Testing

MORRIS BRENNER
Assoc. Technical Service Engineer, Burndy Engineering Company

LAWRENCE KRAUS
Project Engineer, Fairchild Camera & Instrument Corp.

TESTING OF CONTROL COMPONENTS and assemblies at low temperatures, as required to measure performance under adverse conditions, is accomplished effectively in cold chambers. Some military specifications call for testing at −100 F which requires an appreciable time to reach, and places a considerable incentive on methods of testing and circuit connection that minimize loss of refrigeration.

In the set-up shown in Fig. 1 designed by American Research Corporation, Bristol, Conn., to performance test Fairchild precision potentiometers, leads from test units are brought ouside through two 100-socket disconnect panels installed as terminal boards in the inside and outside wall of the cold chamber.

Components under test are equipped with leads terminating in a crimped-on pin with an insulating sleeve. Pin is inserted into a socket on the panel where it is held by a spring shown in Fig. 2. Sockets and pins are silver plated;

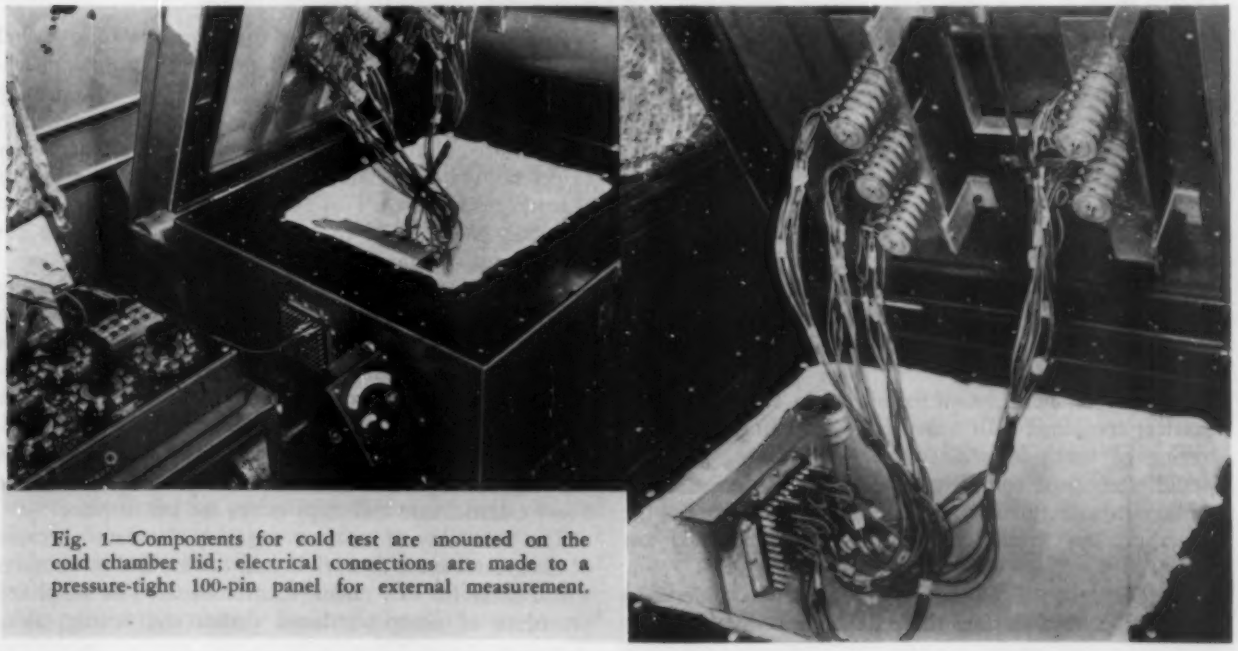
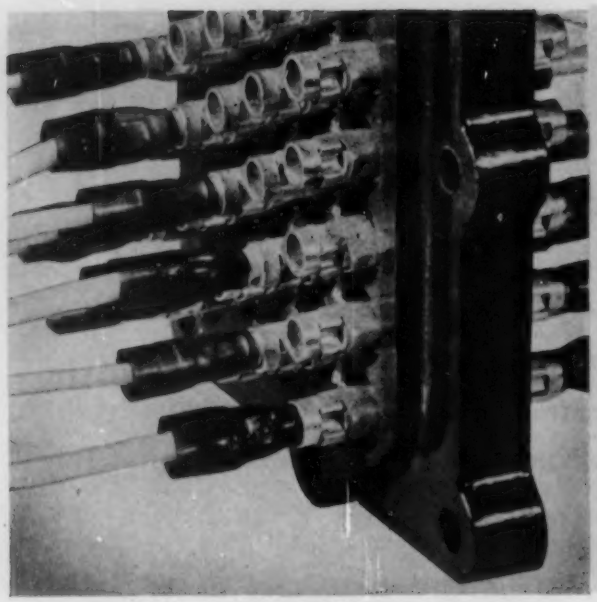


Fig. 1—Components for cold test are mounted on the cold chamber lid; electrical connections are made to a pressure-tight 100-pin panel for external measurement.



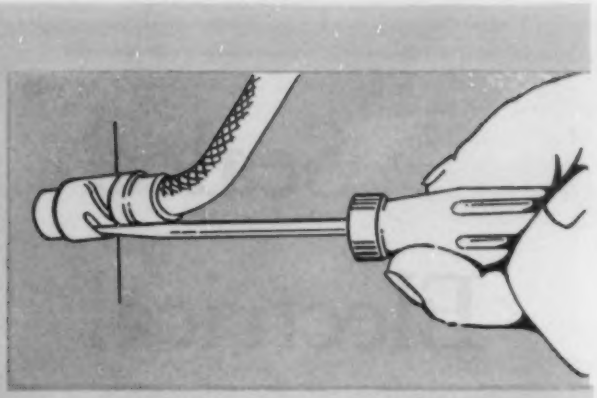


Fig. 2—Pin crimped on lead is inserted into socket and retained by a spring engaging shoulder on the pin. Pointed tool inserted in spring releases the lead.

retaining spring is gold flashed and silver plated. At the end of the test the pins are readily removed by releasing the locking spring with a pointed tool and pulling out the pin.

Spring contact design maintains a stable, low millivolt drop; circuits are readily identified by number and position, have high insulation resistance; equipment takes leads through the range from AN22 (0.032 in. dia) through AN6 (0.218 in. dia). Sockets are molded as inserts in a phenolic pressure-tight panel requiring a bulkhead opening less than 2½ x 4 in. for 40 terminals, or 5 in. square for 100 connections.

Test connections to the terminal panel mounted on the exterior of the cold box may be made by spring clips, as shown in Fig. 1 or spring-retained pins may be used as on the inside panel for more permanent connections.

Sealed Panels Simplify Design and Installation

J. I. GIFFORD
Ordnance Engineer, New York Naval Shipyard

MANY TYPES OF ELECTRICAL EQUIPMENT operate most effectively when the heart of the apparatus is isolated from the external environment. This is frequently difficult to achieve, particularly when the unit must be capable of easy installation and servicing. Where a large number of control cables are involved, the problem becomes even more difficult.

Precision fire control computing and indicating equipment must be manufactured in a carefully controlled environment. All of the time, expense, and care, which go into the manufacture of this type of equipment is lost if during installation, or servicing, careless handling results in exposure of the component parts to undesirable environment or man-made hazards.

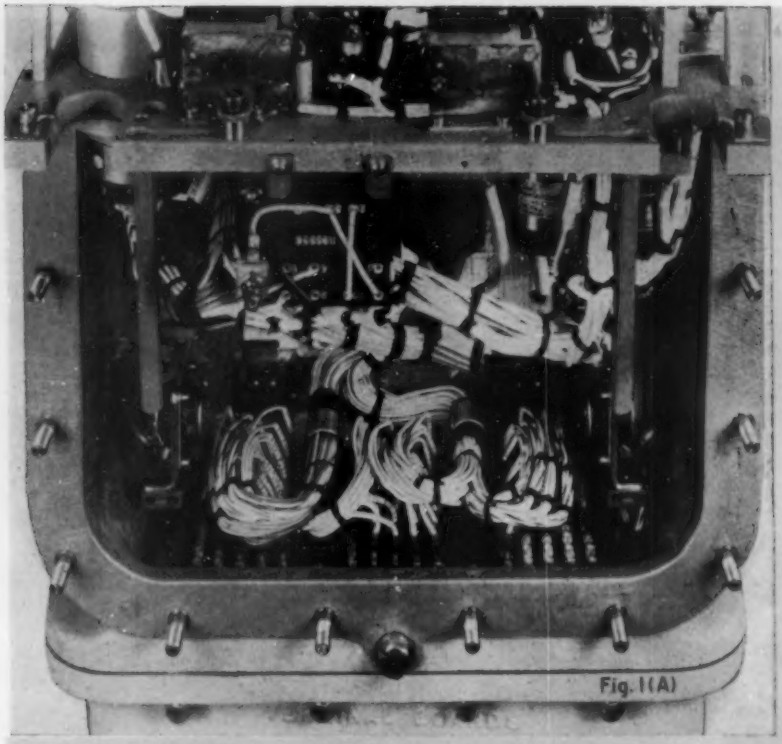
In the equipment shown redesigned in Fig. 1 the tight quarters combined with heavy cable bunching and faulty treeing of harnesses with conventional wiring methods would often cause complete stoppage of the device. Ships cables were sometimes forced in so hard against some of the miniature, low torque components that they could not rotate.

A redesign of the terminating technique was undertaken in an effort to overcome these difficulties. Standard terminal blocks were replaced with pressure-tight molded plastic panels. Sockets in these panels have locking springs which hold the pins in place securely, and molded-in numbers makes circuit identification simple.

In addition to cutting down the reworking time several other advantages have resulted. During manufacture, checkout tests, inspection, and alignment, are considerably simplified as the heavy external case can be omitted during this stage of manufacture making the internal parts easy to get at. When everything is checked out final assembly is made to the case. This has been found to greatly ease handling of units in the shop, as well as making for speedier installation.

Installation time is reduced considerably because treeing and harnessing can be eliminated. Sealed terminal compartment is readily accessible, as shown in Fig. 2. Cables can be easily fanned into the panels without elaborate harnessing. Replacement of the interior mechanisms is now possible without dismounting the entire unit as was previously required. All that is necessary is to disconnect the inside pins and remove the operating mechanism. The heavy external case and ships cables are left in place.

The possibility of error on assembly is reduced because of the greater space to work in and the molded in numbers which make for easy circuit identification. The simplified procedure of using numbered panels and wiring tables



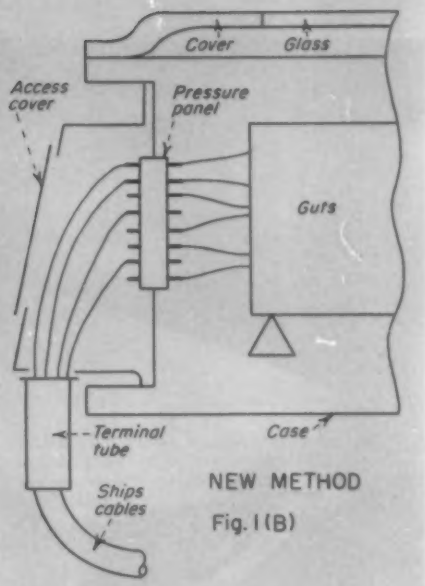
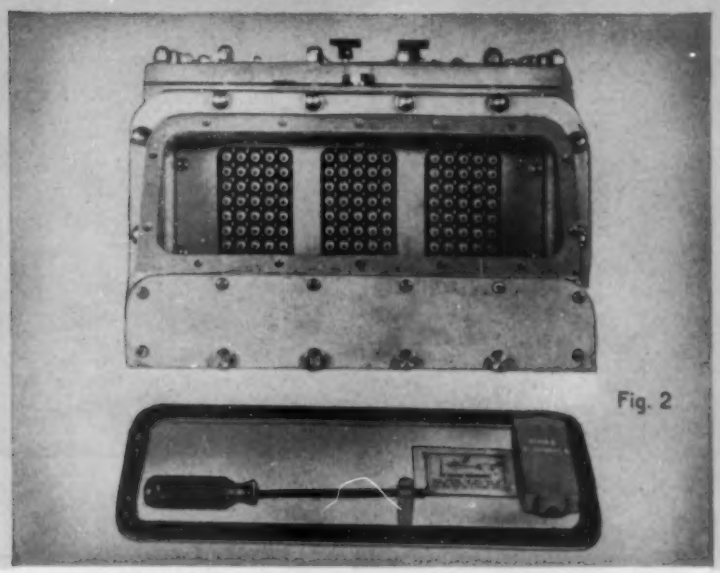


Fig. 1—This Naval visual indicating device for displaying fire control information on board ship required a large number of leads installed in limited space. Addition of a pressure-tight terminal board made it possible to install the empty case and mount the operating unit later.



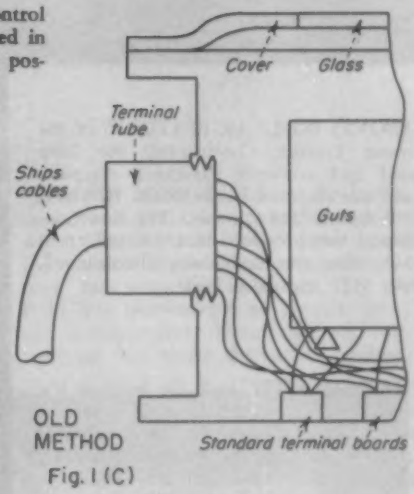


Fig. 2—External connections are out in the open and accessible without opening the case. Pointed tool is used to release spring in socket so terminal pin can be taken out to open a connection.

makes for a more fool-proof installation.

During installation to the ship the empty external case can be installed and wired without the precision equipment. Similarly, the precision parts can be easily serviced below decks when required without disconnecting the ship's cable. If necessary a spare unit could be quickly put in place without the lengthy, time-consuming job of rewiring the ship's cables to the parts. Routine checking and repair is made considerably easier since it is necessary to open only the terminal compartment rather than the entire unit.

When using terminal block designs, it is frequently necessary to make internal jumpers in the equipment. The use of a unit wired up with pressure-type panels permits all this jumper wiring to be done internally in the shop and eliminates the need for the installer to spend time on this.

(ABOVE) POPULAR FEATURES of the former Lincoln Continental, the long hood and compact passenger compartment are retained in the Mark II. Overall length is 218.4 inches. The first Continental was produced in 1939, and up to 1948, when the model was discontinued, only 5322 had been built.

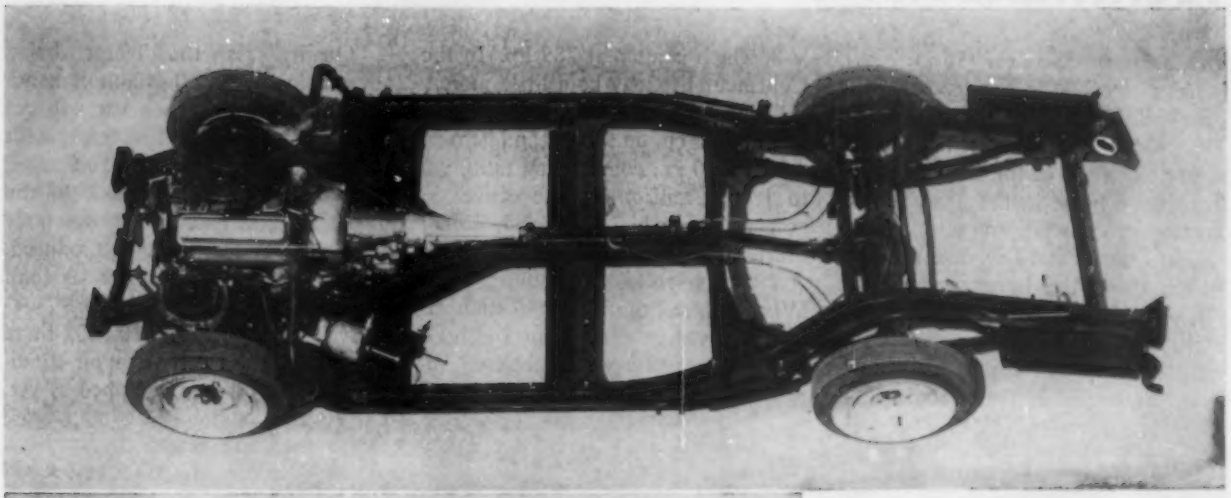
THE REAR VIEW, with the bulge in the trunk cover showing the angle at which the spare tire is mounted. Twin exhausts protrude through the bumper assembly, with the mufflers located immediately behind in the rear fender. The left taillight can be moved aside for access to the fuel tank cap.

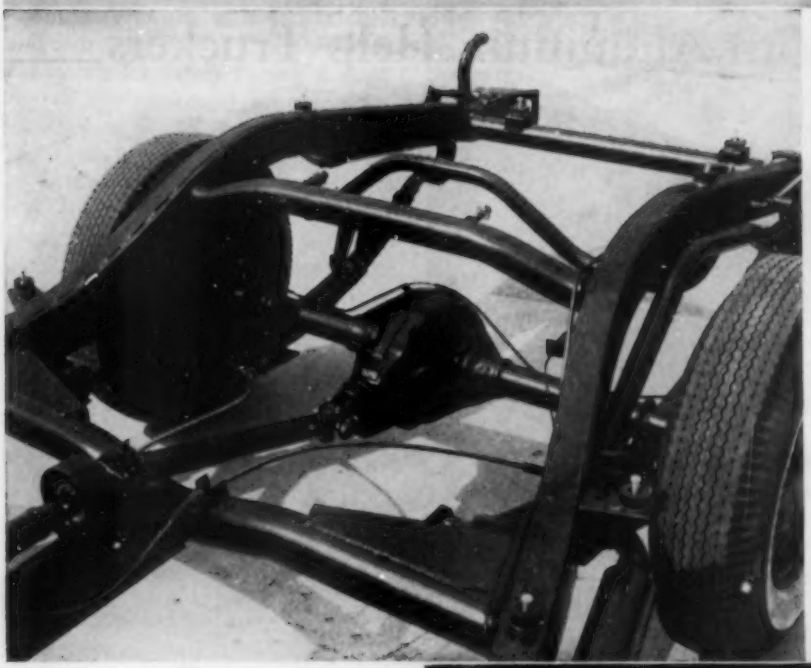
The Continental Mark II—a Luxury Item

The design of the Continental Mark II, Ford Motor Company's entry into the extra-plush automobile market, has been a long time in getting to the public. As was the case with the 1955 Chrysler line before it was shown, the rumor campaign has been whipped up to a point where everyone has been speculating as to the appearance of Ford's "$10,000 car." Several "guess" sketches have appeared in newspapers. Contrary to popular opinion, the bumpers are not gold plated, nor are the seats mink-lined.

The "Mark" system of identifying a car is the same as that used by the Jaguar. No year is included, for a new model will not be introduced each year. Although called the Lincoln Continental then, the first model came out in 1939 and was produced with slight modifications until 1948.

Actually, no price has been set on the Continental, because the per-unit production costs have not been determined. But the $10,000 figure is thought to be a close guess. Presently, 16 cars a day are being built, with the total for the year to be over 3,000, but not more than 4,000. At this





(ABOVE) SIDE RAILS of the modified ladder type frame are widened to permit lower overall height without losing any headroom. In this frame, full foot wells front and rear required discontinuous side members offset by a 16 in. right angle joint at the leg location just behind the front wheel. Torsional rigidity of the frame has been increased with stronger individual crossmembers. Note mufflers at extreme right, top and bottom.

(BELOW) FOUR DIALS on the instrument panel point up an uncluttered interior. The dial at the left is made up of four smaller fuel, oil pressure, temperature, and amperage indicators. To the right is a speedometer, an electric clock, and a tachometer. Heater and air controls are just above the tunnel housing.

(ABOVE) THE REAR AXLE of the Continental Mark II is of the semi-floating type in which the axle shafts carry the wheels, and are subject to bending as well as torsional stresses. The axle housing is built up with a malleable iron carrier into which tubes are pressed and welded.

writing, about 1,000 orders for the car, sight unseen, have been received by Ford, with half of them accompanied by deposits ranging from $300 up to $10,000.

Style-wise, the Continental front end is not too different from the Thunderbird, Ford's sport car. But there the similarity ends. The car blossoms out to a size almost equal to the 1956 Lincoln. The Continental overall length is 218.4 in.; width, 77.5

inches. A low-slung car (56 in. high), it has a "step down" design. But the drawback here is that the frame is so low that the driveshaft had to be mounted on top of the frame, producing a huge bulge in the floor, supplemented by deep-pile carpeting.

The Continental Div. does not plan to announce the horsepower of the car, now or ever. It will be simply advertised as "adequately powered," something new in advertising. However, the engine is the 1956 Lincoln V-8, which is rated at 285 hp. In the Continental it may be a little more.

Other engine statistics: displacement, 368 cu. in.; bore and stroke, 4.00 x 3.66 in.; compression ratio, 9.0 to 1; transmission, torque converter; gear ratios: first, 2.4; second, 1.467; third 1.0. Springs: front, independent coil spring; rear, semi-elliptical leaf. Wheels: wheel discs have 40 stamped vanes bolted in place; rim width, 6 in.; tire size, 8.00 x 15, tubeless. Approximate weight: 5,000 pounds.

"Quality" is the factor being stressed in the car. It is almost hand-built all the way. Each car will get a shakedown on the test track, with some tests running up to 100 miles. After that, the cars go back to the plant for a final check. Only one body style, the two-door, is being produced. The car is strictly a 4-seater. A four-door model may be added later.

Even at a cost of $10,000, there will be one extra cost item: air conditioning. No cars are equipped as yet.

Weight Savings With Aluminum Help Truckers

Aluminum seems to be the answer in the search for weight savings in the trucking industry. One big aid in this respect is a 35 ft. all-aluminum welded flatbed truck trailer offering a 3,000 lb. increase in payload. The trailer was designed by Kaiser Aluminum & Chemical Corp., and is being produced by Beall Pipe & Tank Corp., Portland, Oregon. Another conversion from steel to save 120 lb., is this forged aluminum equalizer beam, designed by Alcoa.

The aluminum trailer uses Kaiser's new 5083, non-heat treatable, high magnesium alloy, which has good weldability using the inert-gas, shielded-arc, consumable electrode process. An aluminum floor plate, three feet wide, and ½ in. thick extends the full length of the trailer, serving as part of the frame. This plate, the outer floor plates, mounting pads, and cross members are welded to the two main beam webs running the full length of the trailer. With a maximum payload of 45,000 lb. concentrated over the center 15 ft. of the trailer, the max. deflection was ¾ inch. Other aluminum parts are: the landing gear and braces; forged disc wheels; and axle-hub-drum assemblies.

Alcoa's 48 in. aluminum equalizer is used in the tandem axle suspension. The equalizer beam assures equal division of the truck load by keeping all four wheels on each side in contact with the road at all times. Alcoa alloy 2014-T6 is used for the forging. At right, directly above the equalizer beam, is an aluminum beam saddle made from a permanent mold casting.

Testing Laboratory On Wheels

"Taking the laboratory to the problem" is the concept of a new contract testing service just made available to engineering concerns in the Detroit, Mich. area. Operated by Albert Sniderman, a mechanical engineer, the mobile testing laboratory is housed in a half-ton panel truck, and holds more than $6,000 worth of testing equipment such as a surface roughness tester; an optical comparator; a sound level meter; sound analyzer; oscilloscope; amplifier; and strain gages.

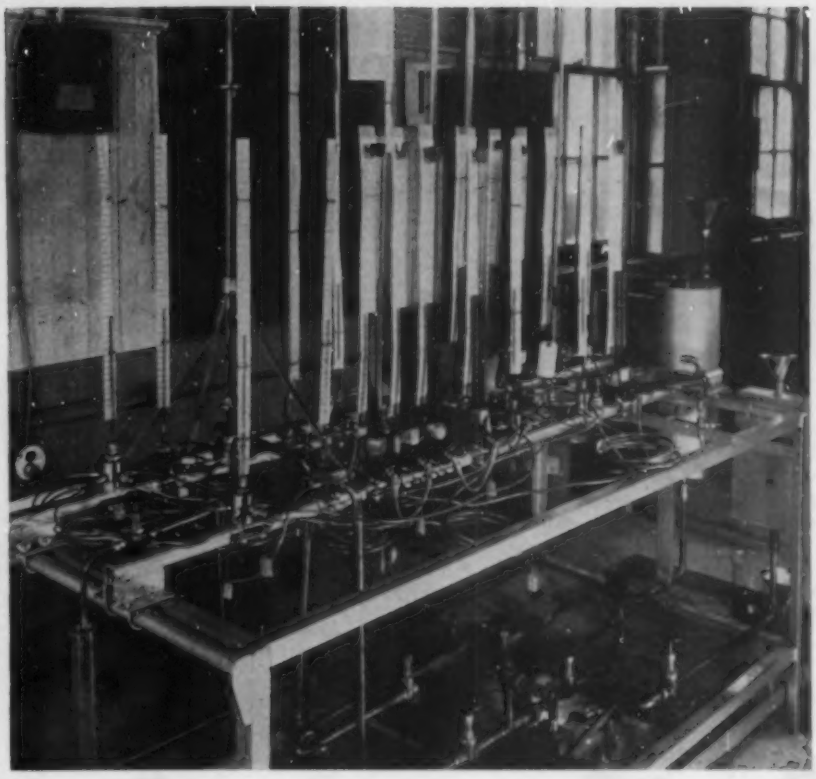
Sniderman works on both a research and consulting basis, and has designed his mobile laboratory for inplant testing of manufacturing processes and equipment; inspection for contract specification compliance; and testing of product performance under field conditions. It will make possible the testing under full work load of equipment which cannot be moved to the laboratory. Some examples: dynamic loads in installed conveyor chains; noise of fan installations; cycle timing of spot welders; vibration in machine tools; and field tests of earth moving equipment.

In the truck, instruments are strapped to shelves for protection against shock. On the field tests, the truck carries an auxiliary generator to power the electrical equipment.

Fast Working Automotive Air Conditioner

Regardless of the outside temperature, the new air-conditioning unit used in the new Packard will cool the inside of the car to a comfortable level in 90 seconds. All of the components are located under the cowl or in the engine compartment. The system is in operation only when needed, with the need thermostatically controlled. A magnetic clutch disengages the compressor when the temperatures are being maintained, or when the system is not in use.

The cool air outlets are located on the upper portion of the instrument panel or at the floor. A single control on the instrument panel maintains the desired temperature. In combination with a fresh air heater, features are a simplified design and installation.



Fluid Analog Studies Air-Conditioning Loads

The assorted collection of vertical glass tubes shown here comprise a hydraulic analog, a device used at the Sibley School of Engineering at Cornell University, Ithaca, N. Y., for the analysis of thermal circuits. Specifically, the fluid analog is used to study periodic heat flow in complex air conditioning systems, and the setup here represents a study of the cooling loads from sunlit glass and walls of a typical office building.

Like studying an electrical circuit of grouped resistances and capacities subjected to a periodic voltage, a thermal circuit can be studied by grouping the thermal resistances and heat storage capacities. This is done by substituting laminar fluid flow for heat flow in fluid circuits with resistance tubes and fluid storage tubes. The resistance and storage elements are calibrated to simulate the grouped components of the system after the flow, temperature and time scales have been selected. In these studies, one minute in the model indicates one hour in the system; a liquid level increase of one inch represents a temperature increase of one degree F. A cooling load cycle, then, means a model cycle of 24 minutes.

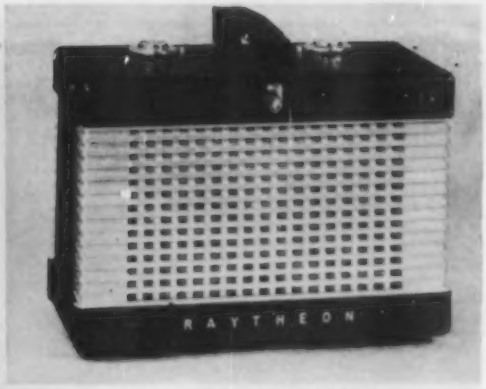
Copper tubing of the correct I. D. and length connect each glass tube with every other one, and simulates the grouped thermal resistances. The glass tubes of larger cross section simulates the grouped heat storage elements, like thick stone or concrete walls, while the smaller diameter tubes of less volume indicate temperatures like air, floor surface, and enclosure surface. The size of the resistances depend upon the viscosity of the fluid and scale factors. A change in the viscosity from that calibrated for the tube will affect the scales.

Finding a positive displacement pump with a variable, periodic rate of delivery was the main problem. This was resolved with two bellows driven through a cam-operated phasing mechanism. There is no delivery when the bellows are out of phase; but maximum fluid displacement is obtained when the bellows are in phase. A cam revolving once every 24 minutes controls the phasing, and any variable heat source may be simulated by using a different cam.

THE NEWS IN PICTURES

AFTER A VERTICAL TAKEOFF like a helicopter, Bell Aircraft Corp.'s XV-3 Convertiplane will tilt its combination three-bladed rotor-propellers forward 90 degrees, and the plane will fly like a conventional model. As shown here, the XV-3 can be maneuvered in every direction as a helicopter. The conversion to forward flight takes from 10 to 15 sec with no loss of speed or altitude. The pilot can safely stop or reverse the conversion at any point and maintain stable flight with the rotor-propellers in any intermediary position. The speed of the convertiplane is said to equal that of a DC-3 which cruises at about 180 mph.

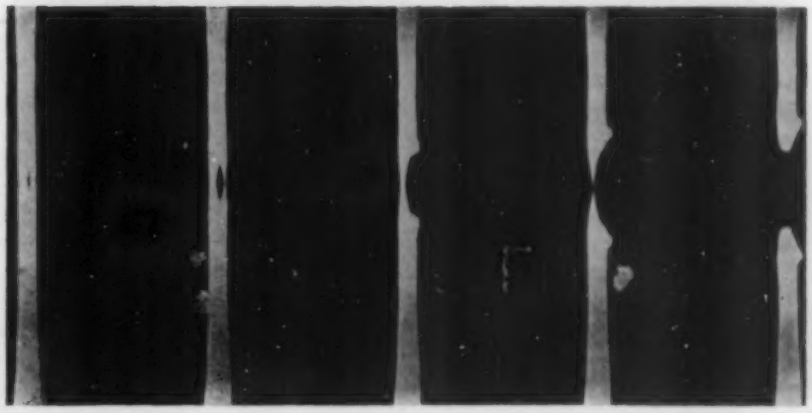
THIRTY FEET LONG and 8 ft. in diameter, this fibrous glass container is used by Northrop Aircraft, Inc. for shipping the major components of their Shark missile. Advantages are: savings in transportation costs because of light weight; corrosion resistant; low production and maintenance costs; no painting required; less costly handling equipment; outdoor storage use. The containers are made by Precision Pak, Inc., Paoli, Pa., and have premoulded skid inserts, and balsa ribs for reinforcement. A spring suspension system using standard automobile leaf springs and shock absorbers protect the contents. Units are clam-shell in shape, and are cured in an oven under pressure. A repair kit consisting of fibrous glass material and a bonding compound permits patching and laminating of the material to the damaged portion of the container. The mended portion is as strong as the rest of the unit.

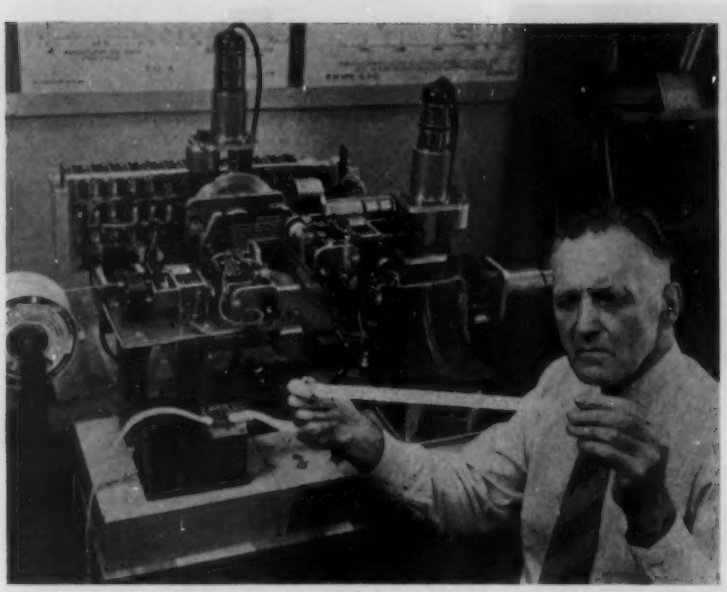


USING ONLY ONE SMALL "A" pack battery, this new twin-speaker, transistorized portable radio made by Raytheon Mfg. Co. will play for 2,500 hours, or for two years of normal use. And, if the A-type battery is not available, the radio will operate for 500 hours on the power from four standard flashlight batteries. The set uses seven transistors, needing little battery power, and has two 5-inch speakers for improved tone quality. No plug-in attachment is necessary. The set measures 12 in. wide, 8 in. high, and 5½ in. deep, has a hardwood cabinet and weighs 8 pounds. Price: $89.95.

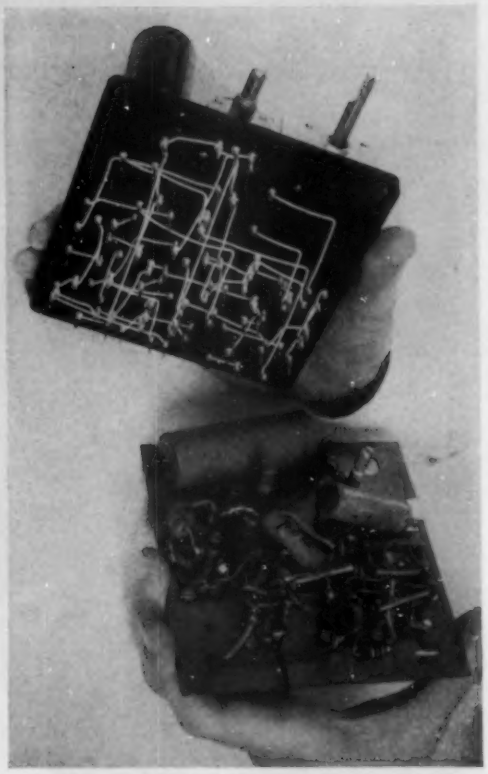
LOOKING MORE LIKE A MICROPHONE than the portable pyrometer that it is, this land surface pyrometer will give accurate temperature readings within 0.5 per cent of metals and refractories, and can be used for measuring spot temperatures in a range from 100 F to 2400 F. The measuring head is mounted on a telescopic arm which can be extended to length of 9 ft., and is connected to a temperature calibrated millivolt meter. According to the manufacturers, Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa., the pyrometer will measure the heat at 3/16 in. below the surface of a hot steel billet, rather than the surface. With refractories, the depth of measurement is 1/16 inch. The instrument is not intended for continuous measurement inside furnaces.

HIGH-SPEED PHOTOGRAPHS show here that a stretched rubber band usually breaks from the "inside out." Total elapsed time for this five picture sequence, taken at the General Electric Research Lab. in Schenectady, N. Y. was about one-three-thousandth of a second. After the band has snapped, the ends fly apart at speeds up to 500 mph. The pictures were made in conjunction with G.E.'s basic studies of how and why different materials fail. One of their chief interests is increasing the strength of the new silicone rubbers, but it has been noted that there are similarities between the snapping of a rubber band and the breaking of metal construction materials.





R. F. MALLINA, designer of the M-4, inspecting the punched tape which is fed to the machine. He sees the day when electrical components will be manufactured on several machines receiving instructions from a common source.



TWO FIVE-TUBE RADIO RECEIVERS. The one at bottom has been wired by conventional soldering methods; the one at top by Bell Labs' automatic wiring machine. The technique can be used on plastic panels having parts on one side, with terminals protruding through holes on reverse side.

Tape Controlled Wiring of Complex Parts

An experimental machine which automatically wires complex electrical apparatus, has been developed by Bell Telephone Laboratories to study parts and equipment designs best suited for automation. Directions are fed to the machine from a punched tape, then resolved into electrical signals which control the machine in the wiring operation.

Called the M-4, the experimental machine uses a process for making solderless connections, also developed at Bell Laboratories, (*Product Engineering* June 1953, p. 230). Connections are made by wrapping six turns of solid-conductor wire around a rectangular terminal, eliminating all soldering.

Two rotating spindles are used in the machine, and wire is fed from a spool. One spindle pulls the wire in an inverted L-shaped movement to a connecting terminal. At the same time, the wire is cut to the correct length at the second spindle. The spindles remove some of the insulation from each end of the wire as the ends are wrapped around the terminal. The spindles then pick up the supply wire from the spool to repeat the process at the next terminal. Such a method of wiring will obviate the need for preparing and handling many short pieces of wire.

The M-4 can be used with plastic panels, all alike, having various types of mounted parts such as electron tubes, transistors, resistors, or the like. The terminals of the parts protrude through holes in the panels spaced at regular intervals.

Radioactive Waste Used For Atomic Batteries

One of the major problems connected with the operation of nuclear reactors is the resulting radioactive waste products which must be disposed of. One way to get rid of these waste products is to bury them in huge tanks in the ground. However, continuous monitoring is necessary for a number of years to check for leakage. Another method is to place it in a cement block and drop it in the ocean.

"There is another way," says Dr. E. G. Linder of the Research Center of the Radio Corp. of America, at Princeton, N. J., "but in this case the radioactive waste can be used in atomic batteries to provide an auxiliary power source." Dr. Linder made his announcement at the International Conference on the Peaceful Uses of Atomic Energy held in Geneva.

In a review of the research on atomic batteries and other direct conversion devices, Dr. Linder estimated that if all the electrical power consumed today in the United States were produced by nuclear reactors, the radioactive waste material left over from this process would generate radioactive energy at the rate of 400,000,000 watts. This is only a few hundredths of 1 per cent of all the energy consumed in the country. This

figure is further reduced because the radioactive energy could not be converted into electrical energy with more than a few per cent efficiency.

Dr. Linder added that fission products cannot be considered as a possible principal source of power; in fact, their use in large quantities varies directly with the use of reactors as the principle source of commercial electric power. As an auxiliary source of power, the power produced from fission products would roughly equal that produced by batteries at the present time—about 2,000,000 watts.

Automation in San Francisco

Everyone at the Symposium on Electronics and Automatic Production in San Francisco a few weeks ago was in agreement that "the automation industry will soon become the nation's greatest industry, with annual sales in the billions of dollars." Sponsored by the Stanford Research Institute and the National Industrial Conference Board, Inc., the Symposium was attended by more than 500 officials from almost as many companies. Speakers were: Paul B. Wishart, Pres., Minneapolis-Honeywell Regulator Co.; Dean E. Wooldridge, Pres. of the Ramo-Wooldridge Corp.; Robert T. Keller, Vice-Pres. of the Chrysler Corporation; and W. K. Scott; Staff Engineer with U. S. Steel Corporation.

Mr. Wishart said that small business must expect that its course will be changed by the growing use of automation. "Small business faces two two alternatives. The first is to be caught flat-footed, and forced to fight rear-guard actions, attempting to anticipate for, or counter, new competitive conditions. The second is to anticipate through careful study of what is going on in the economy and a particular industry, and to plan a realistic course, thereby gaining the advantage of early action."

Mr. Wooldridge suggested that if industry is to get prompt benefits from automation, it should adopt the "systems" approach now being used in developing complex weapons, rather than the "black box" approach used in the last war. This was a warning to industry not to try to piece together its own complex automation system. What is needed is a competent automation system team.

Mr. Keller cited Chrysler's new Plymouth engine plant as the most modern and most highly automated plant of its kind in the world. He said that the reason for this is the "integrated automation" approach used. Rather than using large inflexible machines. Chrysler used small, fast, more simply constructed units that can be tied together into flexible units.

"Safety" is Theme in New Cars

Last April, Chrysler Corp. announced that it was making safety belts available to dealers for installation if the customer so desired. Then it was announced that the installation was to be redesigned. Latest word is that they will appear in 1956 models.

In July, Ford followed with the statement that all Ford, Lincoln, and Mercury cars from 1952 models on could be equipped with safety belts, at a cost of $11.95 per belt, plus $2 installation charge per belt.

Early in August, Buick announced that it, too, will have optional safety belts in its 1956 line. This could mean that other GM cars will do the same. Five years ago Nash announced seat belts for their cars, but discontinued the offer after selling only 500. It was thought that the lack of interest was caused by a greater lack of advertising.

This year, however, Ford is giving "safety" a big push for 1956, even though they are not sure that there is any demand for safety—to the extent that drivers and riders will strap themselves in a car. Ford says tests have shown that a person has twice the chance of survival if he can stay inside the car in an accident. An additional safety feature along these lines is a stronger door lock to keep car doors from springing open under impact. (See insert, 1956 Lincoln). The only way that the doors can be made to fly open under impact is to sheer away the rotor's teeth, or break the engaging plate.

Another standard safety item like the new door latch, is the "deep-dish" steering wheel. This wheel, which will be on Lincolns and Mercurys and Fords will absorb crash energy and keep the driver's body away from the steering column.

Other standard items: stronger tracks for front seats, and stronger anchors for the rear seat to keep them in place under impact; and a shatterproof rear view mirror.

Available at extra cost: safety belts, front and rear; a vinyl foam safety pad on the instrument panel to cushion shock; and padded sun visors.

Ford expects the safety features will be most effective at speeds up to 50 mph, which has been found to be the range for half the accidents.

COMING EVENTS

OCT. 17-21

37th National Metal Congress & Exposition, Philadelphia, Pa. Meetings will be held in the headquarter hotels, while the exposition will be held in the convention halls. Over 400 firms will have exhibits. Participating societies are: ASM; American Welding Society; Metals Div., of the American Institute of Mining & Metallurgical Engineers; and the Society for Non-destructive Testing. Some sessions of the Welding Society will be: weldability and research inspection; stainless steels; welding titanium and molybdenum; pressure vessels and welding aluminum.

OCT. 23-26

American Gear Manufacturers Association. Semi-annual meeting at the Edgewater Beach Hotel, Chicago, Ill.

OCT. 24-25

Institute of Radio Engineers, Professional Group on Electron Devices, First Annual Technical Meeting, Shoreham Hotel, Washington, D. C. About 1000 engineers and scientists are expected to attend, with a large representation coming from government agencies. Subjects discussed will be: advanced developments and applications of electron tubes and transistors in radio, television, business machines, and military equipment.

OCT. 26-28

4th Annual Conference of the National Industrial Conference Board at the Waldorf-Astoria, New York, N. Y. It will be the first open and unclassified discussion to be held on the harnessing of thermonuclear energy for peaceful purposes. More than 2,000 leaders in government, science, and industry from this country and 24 other nations are expected to attend.

OCT. 31-NOV. 1

The 1955 East Coast Conference on Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md. Held jointly by the Baltimore section of the IRE, and the IRE Professional Group on Aeronautical and Navigational Electronics. Industrial exhibits are planned. Those interested in submitting papers should contact: Mr. Norman Caplan, Bendix Radio Div., Bendix Aviation Corp., Towson 4, Md.

OCT. 31—NOV. 1

11th Fall Meeting of The Magnesium Association, Hotel Biltmore, New York, N. Y. Papers on use, applications and technique of magnesium. For more information, write to: Jerry Singleton, The Magnesium Association, 122 E. 42nd St., New York 17, N. Y.

NOV. 1-3

3rd Annual Meeting of the Investment Casting Institute, at the Sheraton-Cadillac Hotel, Detroit, Michigan. The aircraft industry's views on investment cast parts, and the role of such components in planes will be discussed by representatives of leading aircraft manufacturers. Recent new casting methods such as the glascast process, the Investment "X" and the Ellis processes will be reported on by Dr. N. J. Grant, of MIT who is consultant for the Institute. Other topics to be covered will include, "A Study of the Solidification Phenomena," the progress of investment casting in Europe; and investment casting applications for gas turbines in automobiles. Contact the Investment Casting Institute, 27 E. Monroe St., Chicago 3, Ill.

NOV. 2-4

National Fluid Power Association, Fall Meeting, at the Edgewater Beach Hotel, Chicago, Ill.

NOV. 13-18

Diamond Jubilee Annual Meeting of the ASME at the Congress, Conrad Hilton and Sheraton-Blackstone Hotels in Chicago, Ill. Special features commemorating ASME's 75th anniversary have been planned. More than 300 technical papers at 110 sessions have been scheduled covering a variety of subjects. The American Rocket Society, celebrating its 25th Anniversary, is holding its sessions within the ASME meeting. In addition to the meeting, the "Exposition of Power and Mechanical Engineering" will be held at the Chicago Coliseum. Among the highlights of the exposition will be a series of papers by the Nuclear Engineering Div. of the ASME.

NOV. 14-17

Second International Automation Exposition, Navy Pier, Chicago, Ill. Exhibitors will show instruments, automatic controls, electric computers, control valves, automatic dimensional gages, automation devices, mechanical attachments on process machinery, special production machines, conveyors and lifts of all types, and other devices involving the use of automatic production systems. More information can be obtained from the Director of the Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

NOV. 16-18

Society of Experimental Stress Analysis, Annual Meeting, Hotel Sheraton, Chicago, Ill. For further information: Dr. W. M. Murray, Society for Experimental Stress Analysis, P. O. Box 168, Cambridge 39, Mass.

DEC. 5-9

Exposition of Chemical Industries, Silver Anniversary, at the Commercial Museum and Convention Hall, Philadelphia, Pa. Displays will include varieties of machinery and such apparatus as tanks, conveyors and pressure vessels needed in the processing of raw materials and synthetic substances; the chemical treatment of plating and coating, and others. Another group will show the new applications of metals and ceramics, and plastics in the processing field.

DEC. 12-17

Nuclear Congress & Atomic Exposition, Cleveland, Ohio. Under the leadership of the Engineers Joint Council, a dozen organizations, representing more than 250,000 American scientists and engineers will launch a continuing program of the interchange of information on the developing applications of Nuclear Science by the engineer for vital national benefits. Included will be 100 papers on technical and management subjects.

ABC...and the Reader

BACK IN 1914—forty-one years ago—a group of advertisers, advertising agencies and publishers joined in a project that has come to mean a great deal to the millions who, like you, read business magazines. The project, initiated at a time when circulation claims were rarely verified, was intended to achieve and maintain higher standards of integrity in publishing and advertising practice by providing means to audit paid circulation. Out of that effort came an organization known as the Audit Bureau of Circulations, a voluntary, non-profit, cooperative association, known for short as ABC. Its symbol appears at the head of this page.

We are proud that McGraw-Hill publications were among the founders and charter members of the Audit Bureau of Circulations.

Today the Bureau numbers 3,670 members. These include advertisers, agencies, and publishers of newspapers, farm papers, general magazines and business journals such as this one. These publisher members hold their memberships and their right to display the ABC symbol in their publications only so long as they live up to the circulation standards that are established through the Bureau.

It is one thing to set up high standards; it is another to see that those standards are maintained. This latter and all-important function is performed by a staff of auditors maintained by ABC to check periodically on the circulation practices of the publisher members. When a business magazine, such as this one, joins the Bureau it agrees that the ABC auditors shall have "the right of access to all books and records." Their inspection may dig into the files of original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, editorial expenses and many other significant items. Sometimes the auditors go behind the records and seek verification of purchase and payment from subscribers themselves.

The information thus obtained and certified by the Bureau then becomes available to the public and constitutes an authoritative report on the publication's circulation practices.

The advertisers and agencies benefit directly from the ABC because it provides a generally recognized factual yardstick by which the circulations of member publications can be measured and appraised. Every paragraph in an ABC report on a business publication gives the advertisers data that help them make intelligent use of the publication as an advertising medium.

But the ABC renders a service of vital concern to the *reader* as well. The Bureau audits paid circulation only, and it is through this payment, whether by subscription or newsstand purchase, that the reader keeps the editorial policy of a publication responsive to his needs. His decision to buy or not to buy records his judgment on each publication, and the ABC-audited and certified circulation reports make the sum of these judgments known to all concerned.

So the editors of ABC publications must constantly keep their editorial services up to the mark if they are to survive a competition in which the reader's right to buy or not to buy is paramount. Each paid magazine or newspaper will prosper or fail as it wins or loses the voluntary patronage of thousands or millions of readers. And—the ABC is scorekeeper in this vital contest.

Thus the publisher who submits his publication to the supervision and discipline of ABC affirms in the strongest possible manner his recognition that his primary obligation is to his readers and that he owes the standing of his publication to a voluntary demand by those readers.

All this is what makes the ABC brand on a publication so important to its readers. That respected symbol, testifying to the advertising value of the publication, serves also as a constant reminder to all concerned that the reader's willingness to pay for an ABC publication is the basic reason why it stays in business.

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Design Charts for Precision Gears

R. M. GITLIN
Servomechanisms, Inc.

DESIGN REQUIREMENTS FOR PRECISION SPUR GEARING to be used in instruments, servomechanisms, computers and other equipment differ considerably from those for gears used at high speed and to transmit heavy loads. Accuracy of motion transmitted is the prime consideration. Moreover, there is usually a size and weight limitation, particularly in airborne equipment.

These requirements dictate using gears with a pitch of 64 or finer. The loads are very small; they usually involve rotating a pointer, potentiometer, synchro or similar output transmitter with torque ranges of 0.006 20 in.-oz. Motors as a rule do not exceed 1/50 hp.

In most applications of this type, the output element is driven to one extreme of its travel where it contacts a mechanical stop. If the speed ratio between motor and output element is small and the stop is resilient, the motor may be stalled. If the speed ratio is large, a slip clutch may be included in the gear train to absorb the shock. In either instance, the load at this condition is the maximum that will be transmitted. Therefore, the charts on page 211 and 213 have been developed relating gear width to maximum transmitted torque.

The curves are based on the Lewis Formula

$$L = \frac{SFY}{P}$$

Since the velocity is usually low, calculations were based on a zero velocity factor; that is, $S = S_s$. Four commonly used fine pitches—64, 72, 96 and 120—and nine commonly used gear materials are included.

Table I—Yield Strength and Stress Ratio of Various Materials

Gear Material	Yield Stress, psi	Stress Ratio
3140 Steel	*70,000–150,000	*0.43–0.20
Stainless Steel 416	*50,000–115,000	*0.60–0.26
Aluminum Alloy 24 S-T4	40,000	0.75
Stainless Steel 303	30,000	1.00
Phosphor Bronze	20,000	1.50
SAE 1020	20,000	1.50
Brass	20,000	1.50
Phenolic	8,000	3.75
Nylon	6,000	5.00

* Depends upon heat treatment.

EXAMPLE—Determine the minimum face width of a 64-pitch gear having 20-deg pressure angle and 50 teeth. The material is stainless steel with a yield stress of 30,000 psi. The maximum torque the gear must transmit is 75 in.-oz. at zero velocity.

$$\text{Pitch Radius} = \frac{\text{No. Teeth}}{2 \times \text{Pitch}} = \frac{50}{2 \times 64} = 0.391 \text{ in.}$$

$$\text{Load} = \text{Torque/Pitch Radius}$$

$$\text{Load} = 75/0.391 = 192 \text{ oz or } 12 \text{ lb}$$

$$F = \frac{PL}{SY}$$

$$F = \frac{64 \times 12}{30{,}000 \times 0.408} = 0.0625 \text{ in.}$$

This problem may be solved using the gear width graph for 64-pitch gears. At intersection of 50 teeth and 75 in.-oz. torque, read gear thickness which equals 0.062 in. For materials having yield stress different than 30,000 multiply thickness by stress ratio in Table I. The yield stress of the gear material has been chosen as the allowable stress since the gears have to withstand this maximum torque only when a malfunction causes the gears to drive some output element to its stop. During normal operation considerably lower torques are transmitted through the gearing.

SYMBOLS

L = max safe tangential load at pitch dia, lb
S_s = allowable static unit stress for material, psi
S = allowable unit stress for material at given velocity

$$\left(S = S_s \times \frac{600}{600 + V}\right), \text{ psi}$$

V = velocity, ft
F = face width of gear, in.
Y = Lewis form factor (*Machinery Handbook*, page 711)
P = diametral pitch

ACKNOWLEDGMENT—"The Author would like to acknowledge the assistance of Mr. Hale Smith of the Servomechanisms Engineering Department in preparing the gear charts appearing in this article."

(continued on page 211)

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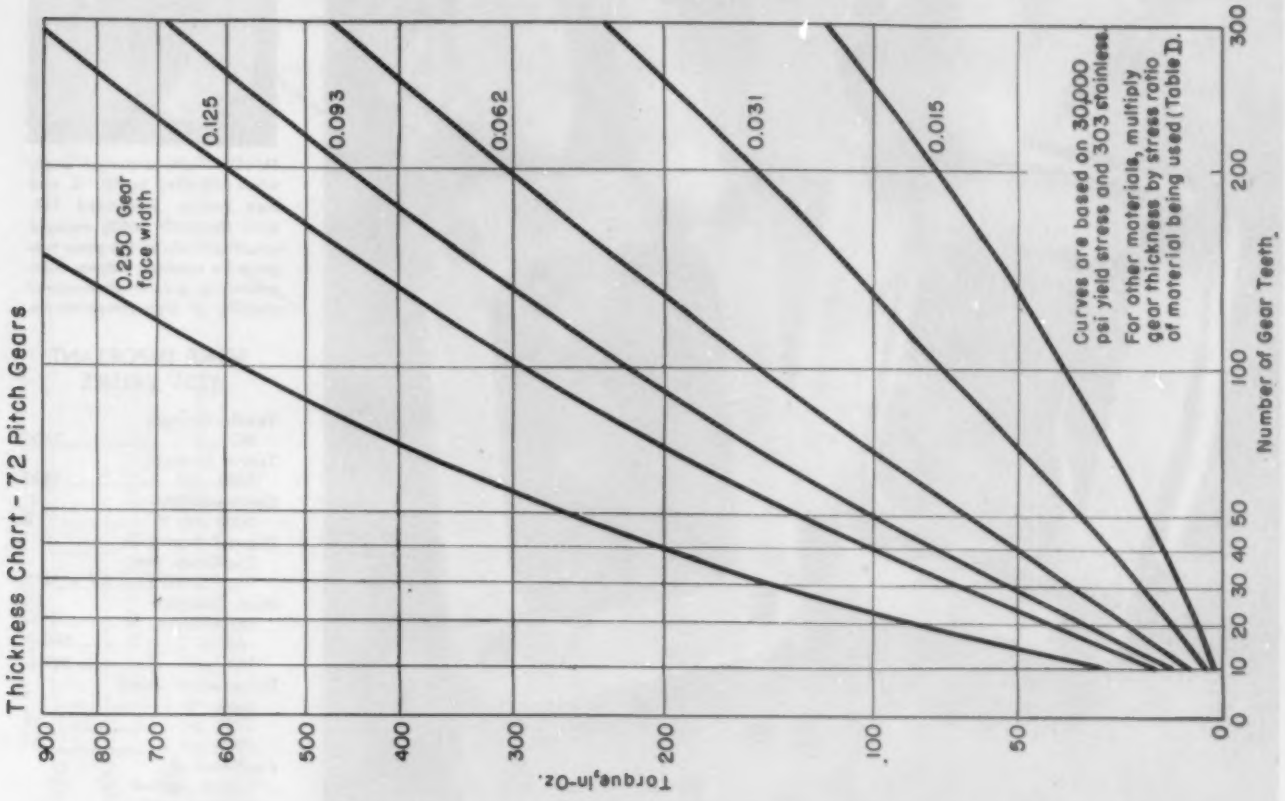
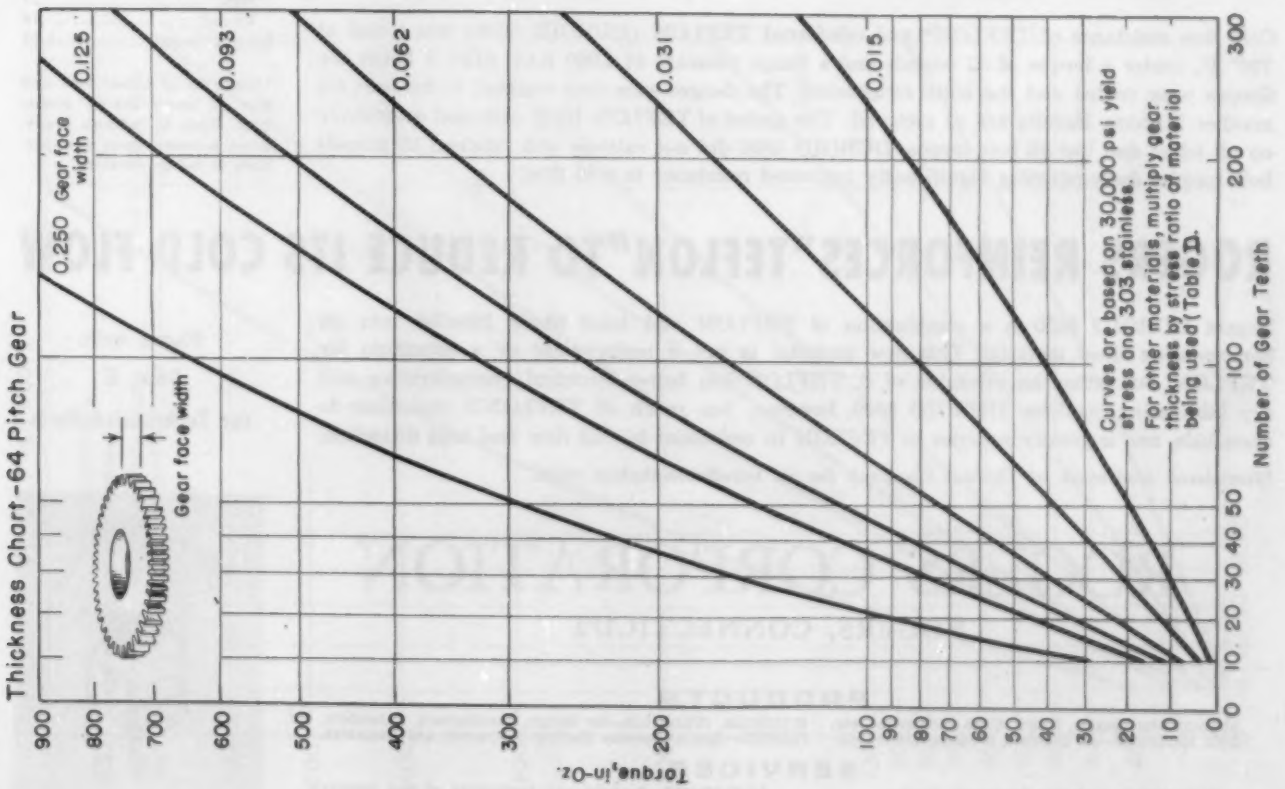
PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Design Charts for Precision Gears (continued from page 209


Thickness Chart - 72 Pitch Gears
0.250 Gear face width
0.125
0.093
0.062
0.031
0.015
Curves are based on 30,000 psi yield stress and 303 stainless.
For other materials, multiply gear thickness by stress ratio of material being used (Table D).
Torque, In-Oz.
Number of Gear Teeth


Thickness Chart - 64 Pitch Gear
0.250 Gear face width
0.125
0.093
0.062
0.031
0.015
Gear face width
Curves are based on 30,000 psi yield stress and 303 stainless.
For other materials, multiply gear thickness by stress ratio of material being used (Table D).
Torque, In-Oz.
Number of Gear Teeth

(continued on page 213)

Cold flow resistance of TEFLON* and reinforced TEFLON (DUROID 5600) was tested at 700° F., under a torque of 35 pounds and a flange pressure of 1,000 p.s.i. After 2 hours the flanges were cooled and the bolts retightened. The flanges were then exposed to the heat for another 2 hours. Results are as pictured. The gasket of TEFLON (left) extruded extensively on all edges and lost all bolt torque. DUROID 5600 did not extrude and retained 15 pounds bolt torque, demonstrating significantly improved resistance to cold flow.

Greater Resistance to Heat Distortion

TEFLON (left) distorted badly when subjected to 720° F. and then cooled. Reinforced TEFLON (DUROID 5600) exposed simultaneously to the same temperature retained flatness, demonstrating greater dimensional stability at high temperatures.

SOME IMPORTANT TEST VALUES

Tensile Strength, MD, psi	2500
Tensile Strength, CMD, psi	1500
Compressibility, 5000 psi, %	8
Thermal Expansion Coefficient per °F., 73-140°F.	2.7×10^{-5}
Heat Distortion Temperature, °F.	
66 psi	500+
264 psi	500+
Deformation under Load, %	
1200 psi	2*
2000 psi	3*
Coefficient of friction against polished steel,	
static	.21
kinetic	.14
Specific Gravity	1.90

*Made up of actual flow and also of compression under load. Data to indicate breakdown between these two portions is being obtained.

ROGERS REINFORCES "TEFLON" TO REDUCE ITS COLD FLOW

Rogers DUROID 5600 is a combination of TEFLON and inert fibers, blended into an homogeneous sheet material. This new material is not a replacement or a substitute for TEFLON, but rather an extension of it. TEFLON has better electrical characteristics and dry lubricating qualities. DUROID 5600, however, has much of TEFLON'S resistance to chemicals, and is greatly superior to TEFLON in resistance to cold flow and heat distortion.

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*Registered trademark of DuPont Company for its tetrafluoroethylene resin.

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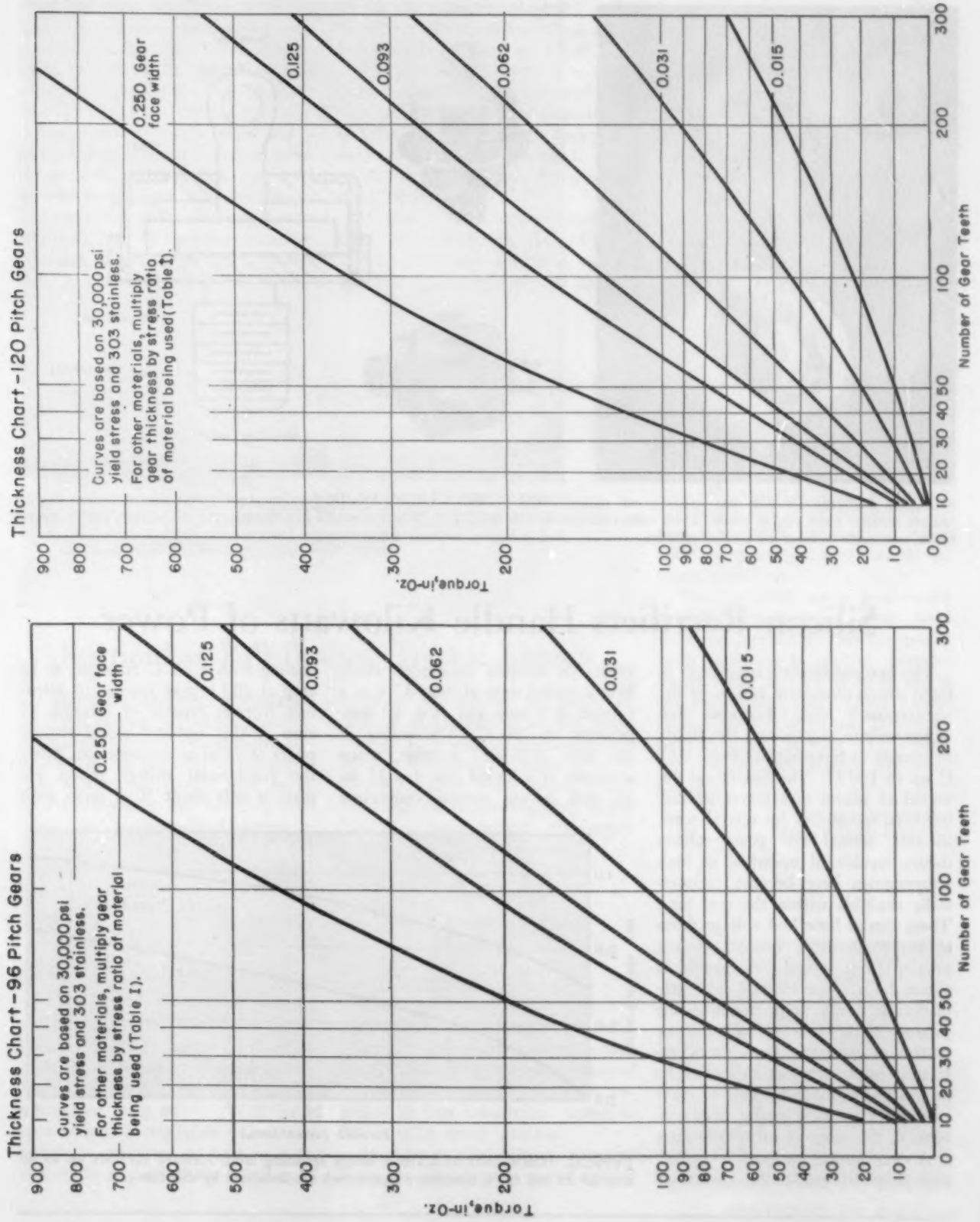
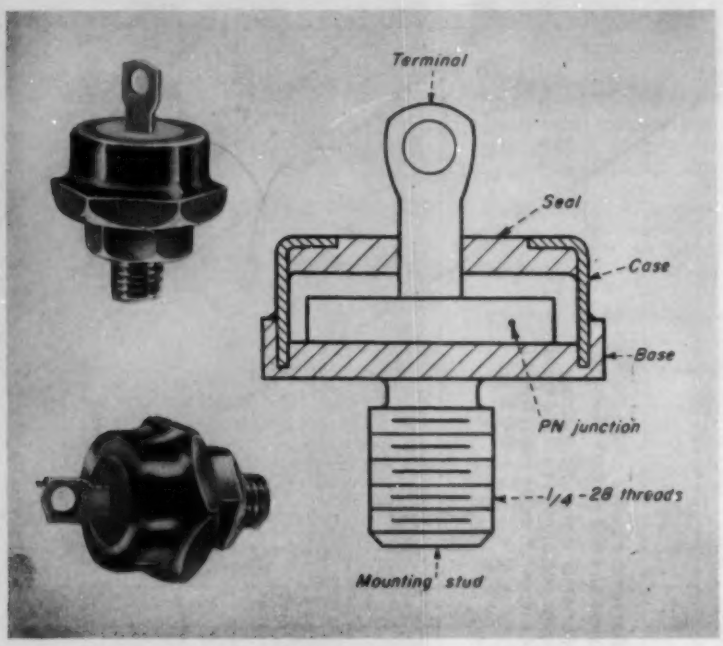
Designing for Precision Gears (continued from page 211)


Thickness Chart - 120 Pitch Gears
Curves are based on 30,000 psi yield stress and 303 stainless.
For other materials, multiply gear thickness by stress ratio of material being used (Table I).
0.250 Gear face width
0.125
0.093
0.062
0.031
0.015
Torque, in-oz.
Number of Gear Teeth
Thickness Chart - 96 Pitch Gears
Curves are based on 30,000 psi yield stress and 303 stainless.
For other materials, multiply gear thickness by stress ratio of material being used (Table I).
0.250 Gear face width
0.125
0.093
0.062
0.031
0.015
Torque, in-oz.
Number of Gear Teeth

SILICON POWER DIODE has capacity of selenium rectifier same size as block. Dark corner of block represents volume of silicon rectifier.

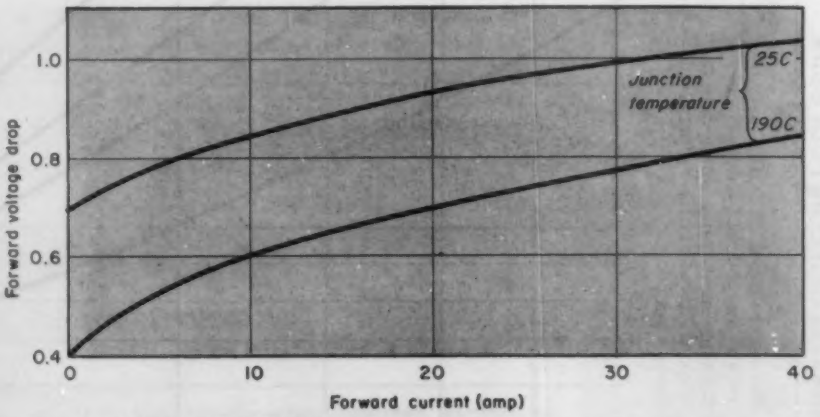


THESE FUSED SILICON DIODES are at present available at ratings of 50, 100, 150 and 200 v. When mounted in a finned case, these units can be operated at higher ambient temperatures.

Silicon Rectifiers Handle Kilowatts of Power

The two outstanding advantages of fused silicon diodes are said to be the phenomenally high efficiencies even in low-voltage systems and the ability to operate at temperatures from —65 C up to 190 C. The theoretical potential of silicon as a power rectifier has been recognized for several years; in fact, several low power silicon diodes capable of operating at high temperatures have become commercially available within the past year. These diodes have had voltage drops at maximum rated forward current ranging from several volts down to about 1.5 v. The internal heat generation is nearly proportional to the product of this forward drop and the maximum current. Thus, it is extremely important that this value be as small as possible in order to make practical a rectifier having rated currents in the range of 10 to 100 amp.

A development program to reduce this drop to nearly the theoretical value has resulted in diodes which have a typical drop of only 0.7 v at a current of 8 amp and at a cell temperature of 190 C. The rating of the new WN-5051 rectifier, when mounted in a finned case 1 x 1½ in. dia and having natural convection cooling with a 65 C ambient, is 15 amp at 200 v peak inverse. A selenium rectifier capable of carrying 15 amp at this ambient would require plates of 45 sq in. cross-section. Since the commercial voltage rating per plate is only about 30 v, seven such



TYPICAL FORWARD VOLTAGE drops resulting from forward currents up to 40 amp (at 25 and 190 C junction temperature) are indicated by this curve.

plates in series would be necessary. Thus the selenium stack would have a volume of about 150 cu in. as compared to 2 cu in. for the silicon unit —a space and weight saving of about 70:1.

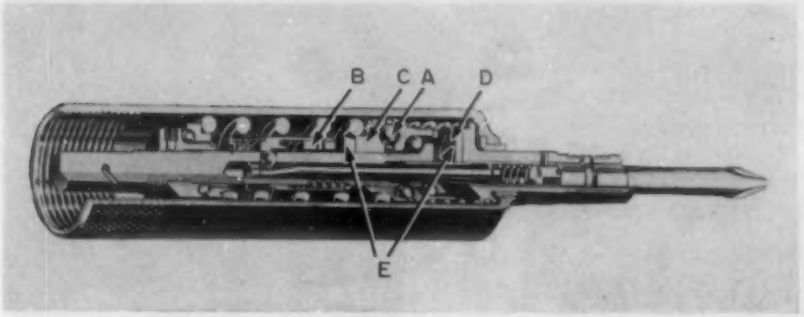
Since each selenium plate has a forward drop of about 1.4 v and seven series plates are required, the total forward drop of the selenium unit is 10 v while that of the silicon is slightly less than 1 v. As a consequence, the efficiency of the silicon cell is greater than 99 per cent as compared to only 95 for the selenium, or, stated a different way, the losses for selenium are five times larger than for silicon.

One obvious advantage is reported to be that silicon can be operated with only moderate deratings at ambients of 180 C while selenium is undependable over 125 C, at the most. As a result, air cooling may be used in nearly all instances.

At present, four voltage classifications are available: 50, 100, 150 and 200 v. They have a forward current rating of 8 amp with natural convection cooling in ambient air at 25 C. Higher current ratings up to 40 amp can be achieved with forced cooling.

Present applications of these diodes include such diverse fields as magnetic amplifiers, rotating rectifiers on the shafts of brushless generators, welders, plating lines, power packs. Diodes having ratings of hundreds of amperes will be available soon. Westinghouse Electric Corp., 360 Collins Av., Pittsburgh 6, Pa.

For more information—
Circle 1, inside back cover



Frictionless, Ball Bearing Torque Limiter

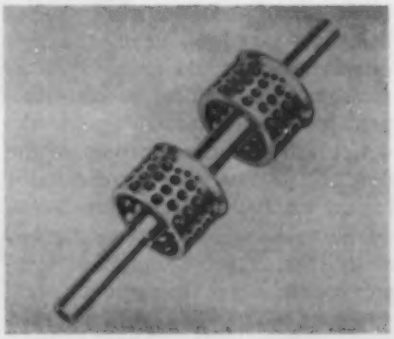
Completely automatic in operation on a ball bearing (A) design principle, a sequential clutch arrangement (B), which is driven as a solid member, permits this torque control unit to go into a completely free wheeling state when the predetermined torque is reached. It stays in free wheeling until it is released from the work. The clutch re-engages the torque-sensitive (C) mechanism when it is removed from the work, but only after the front bit holder engaging blocks (D) have been entirely disengaged.

The limiter cannot be influenced by the operator, and negative angle engaging blocks (E) prevent accidental release due to relaxing of pressure by the operator or fluctuating power pressure. The device is always completely re-engaged and ready for instant action even when the operator works with the power on continuously between operations.

The new clutch can be used on any available power source, from hand tools to automatic multiple-spindle drills, and has a positive, accurate torque range of 5 to 85 in.-lb and is easily adjusted to the desired torque. It is impossible to inpart impact effects to screws or nuts. Livermont, Inc., Maple and Myrtle, Monrovia, Calif.

For more information—
Circle 2, inside back cover

Threaded Perforations Reduce Valve Noise, Vibration



Destructive vibration, trim deterioration, and high noise level which often occur in valves on liquid service is said to be reduced by a recently introduced plug valve. With ordinary valves, a negligible amount of energy is converted to heat as a result of the friction of the liquid upon itself and on the surfaces of the valve. Most of the potential energy becomes kinetic, and, due to the phenomena of cavitation, this kinetic energy is imparted to the downstream piping in the form of severe vibration.

In the new plug's design, threaded holes are geometrically spaced around

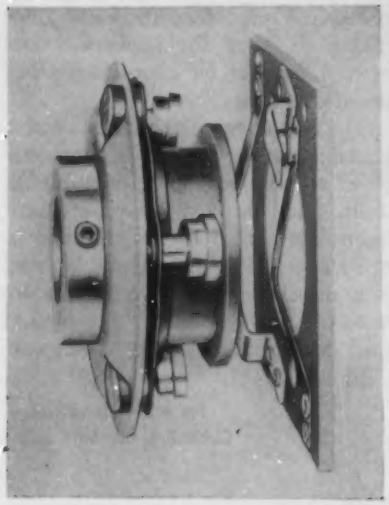
CONTINUED ON PAGE 216

the plug skirt to create turbulence and distribute energy release over a large surface area. Potential energy is converted directly to heat by means of the internal turbulence of the liquid, with the result that less kinetic energy is available for damage to the piping. The rise in temperature of the metals is almost unnoticeable, since a very small amount of heat takes the place of a large amount of mechanical energy.

These new control valves are offered in nominal sizes from 3 to 16 in., with either single or double-seated construction. Plug material and flow characteristics are varied in this new design according to customer specifications. Hammel Dahl Co., 175 Post Road, Providence 5, R.I.

For more information—
Circle 3, inside back cover

Centrifugal Snap Switch Protects Against Overloads

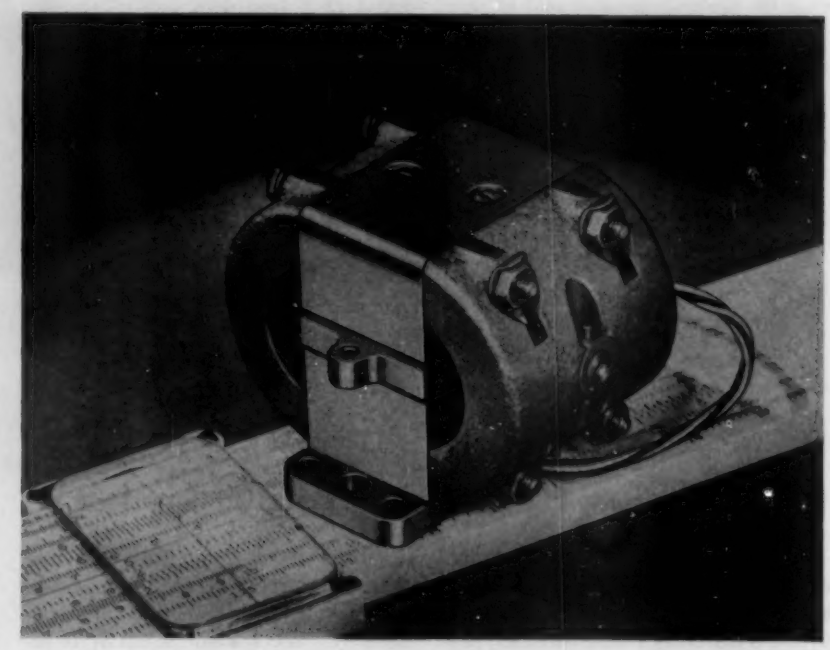


This new switch is especially designed to eliminate the dangerous consequences of overloading as well as belt slippage or breakage or other conditions which would reduce rpm on mechanical or electrical devices. At a predetermined minimum speed, the device will stop the operation of the unit. It is especially recommended for use on appliances such as clothes driers, washers, and air conditioners, as well as electric motors and compressors and other such equipment.

While operating at normal speeds, the rotary section of the switch underspeed control does not touch the stationary switch. No friction or wear is involved. Only when speed falls below the predetermined minimum, does the rotary section move.

Three parts comprise the switch, all of which are frictionless in operation. A simple retaining plate permits positive attachment of the switch to the shaft of the operating unit. To this retaining plate is attached the heart of the switch. This is a one-piece conical shaped disk, made from highest quality, heat treated spring steel. Centrifugal weights are mounted directly onto this disk. When actuation takes place, the disk is moved outward in a horizontal direction. To the disk is attached an insulating spool, which makes the actual contact with the stationary switch. Torq Engineered Products, Inc., Interstate St., Bedford, Ohio. Life expectancy of the switch is 1.5 to 3 million cycles.

For more information—
Circle 4, inside back cover



High Torque Motor Weighs 18 Oz

This motor is designed to drive hydraulic servo valves or other mechanisms which demand fast response and high output force proportional to input current. It is rated at 9 lb of force for 40 ma differential current. It may be driven from two miniature output tubes in push-pull, or from magnetic amplifiers. When magnetic amplifiers drive the motor, low-impedance, high-current coils are available which dissipate the same power.

The stroke of the motor (±0.015 in.) is proportional to input differential current. The displacement sensitivity is ¾ in. per amp, or 20 ma for full-stroke.

This 18-oz motor is assembled with steel dowels and is reported to withstand severe vibration without damage. The armature is of balanced construction so that large lateral accelerations have virtually no effect on armature position. The motor is designed to operate in the ambient temperature range of −65 F to 400 F. Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.

For more information—
Circle 5, inside back cover

CONTINUED ON PAGE 218

A new dimension in motors!

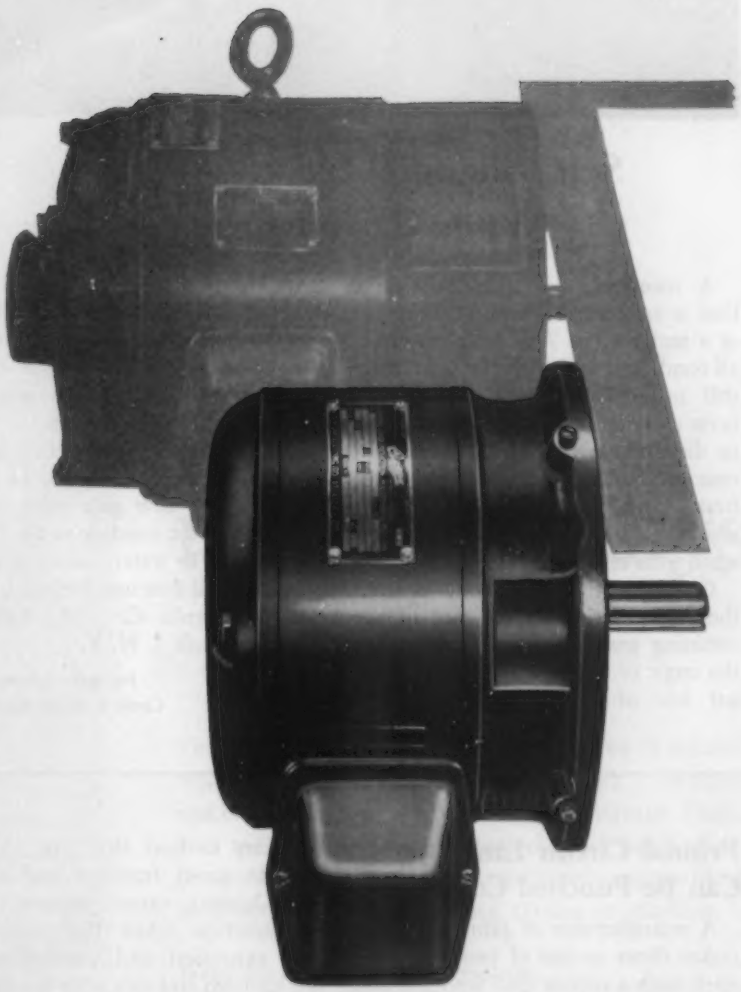
SHORTER Century **Performance Rated® MOTORS**

SAVE SPACE...
SAVE WEIGHT

This new line of shorter, round-frame, end-mounted motors by Century can give you greater freedom in design and engineering. They meet modern demands for compactness and weight-saving ... with even better performance.

No special mountings are required! These shorter Century motors have full-size NEMA "D" flanges. They are interchangeable with all other popular makes of standard end-mounted motors. The shorter motors are available in sizes from 1 to 15 H.P... in open or totally enclosed fan-cooled frames . . . for vertical or horizontal applications.

For full data, call your nearest Century Sales Office.



Performance Rated®
MOTORS
⅛ to 400 H. P.

CENTURY ELECTRIC COMPANY

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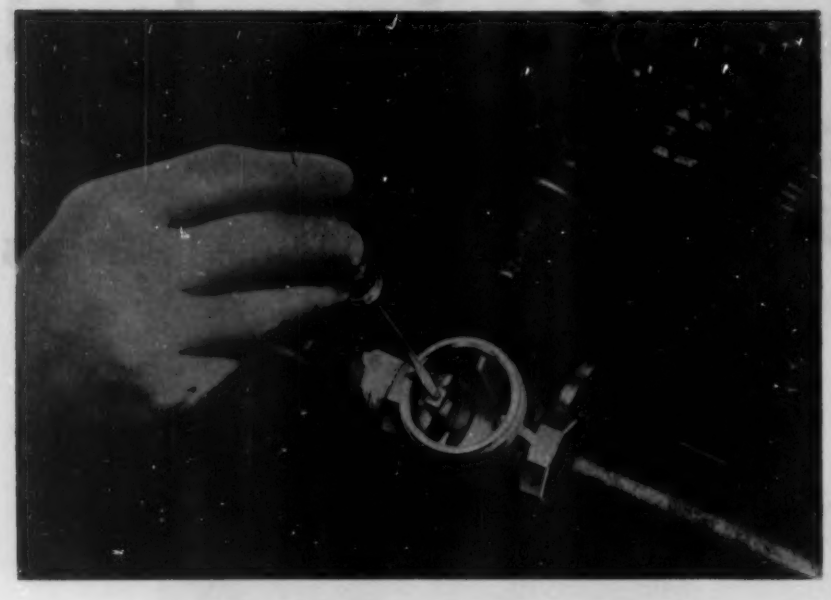
34



Seat Ring Replaced While Valve Remains In Line

A renewable seat ring gate valve that is asserted to assure replacement of a seat ring in 7 to 10 min. under all conditions and with the valve body still installed in the line, has just been announced. It is only necessary to disassemble the bonnet and then unscrew and lift out the seat rings from the body. The new seat rings slip into place and are easily secured again with set screws.

One construction feature is that the angle of the pointed end of the retaining screw is complementary to the angle of the seat ring. The resultant line of contact holds the seat rings securely and rigidly in place without excessive pressure being put on the screws. The screws are silicon bronze. The fine pitch threads of the screw eliminate any possibility of its backing off in service.

Supplied with rising stem and nonrising stem, in ½, ¾, 1, 1¼, 1½ and 2 in. sizes, the new gate valve is suitable for service conditions on 200 lb. steam, 400 lb water, oil or gas lines requiring full flow and frequent operation. Fairbanks Co., 393 Lafayette St., New York 3, N. Y.

For more information—
Circle 6, inside back cover

Printed Circuit Laminate Can Be Punched Cold

A manufacturer of printed circuits makes them in one of two ways. He starts with a copper clad laminate and makes his circuit by etching away unwanted copper. Or, he plates conductive patterns on the surface of a laminate. He must finish the part by blanking it out with a punching die.

Until a recently introduced laminate made its appearance, it has been necessary to heat this type of laminate to avoid fractures and cracks. This heating causes expansion and contradiction when the part cools. The expansion and contraction are not uniform and vary with the amount of heat used and the time the strip of laminate is exposed. This has caused the finished circuit to be off in registration and consequently many rejections result.

Grade XXXP-36 material is not only a high insulation resistance material of approximately 1 million meghom, but, according to the manufacturer, will also cold punch up to $\frac{1}{16}$ in. thickness. Formica Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

For more information—
Circle 7, inside back cover

Heating Elements of Impregnated Glass Cloth

As much as 60 w per sq in. capacity is claimed for this heating element sheeting in special designs. They can be wrapped around surfaces as small as 1 in. dia.

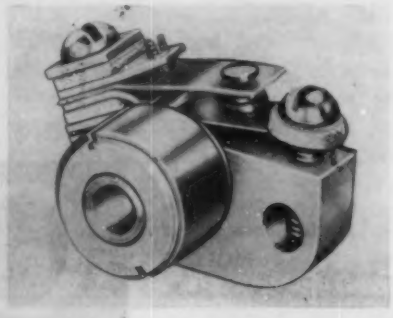
They are made of glass cloth treated with a newly developed inorganic material. They are unaffected by temperatures as high as 600 F, by solvents and by most acids. The new sheets are available in any size up to 36 x 42 in. and in resistances from 10 to 10,000 ohm per sq in. They are UL-approved. Electrical Coatings, Inc., 100 Broad St., Salem, Mass.

For more information—
Circle 8, inside back cover

Miniature Governor For Fhp Motors

A centrifugal governor for fhp motors is made entirely of metal and nonhygroscopic materials, and so is unaffected by fungus or humidity. The unit is designed for use with motors operating on 30 v, dc, or 110 v, ac. Contacts open when a pre-set speed is exceeded, shutting off the power. When speed drops below the set value, the contacts close.

Construction includes platinum contacts, a coin silver-plated commu-



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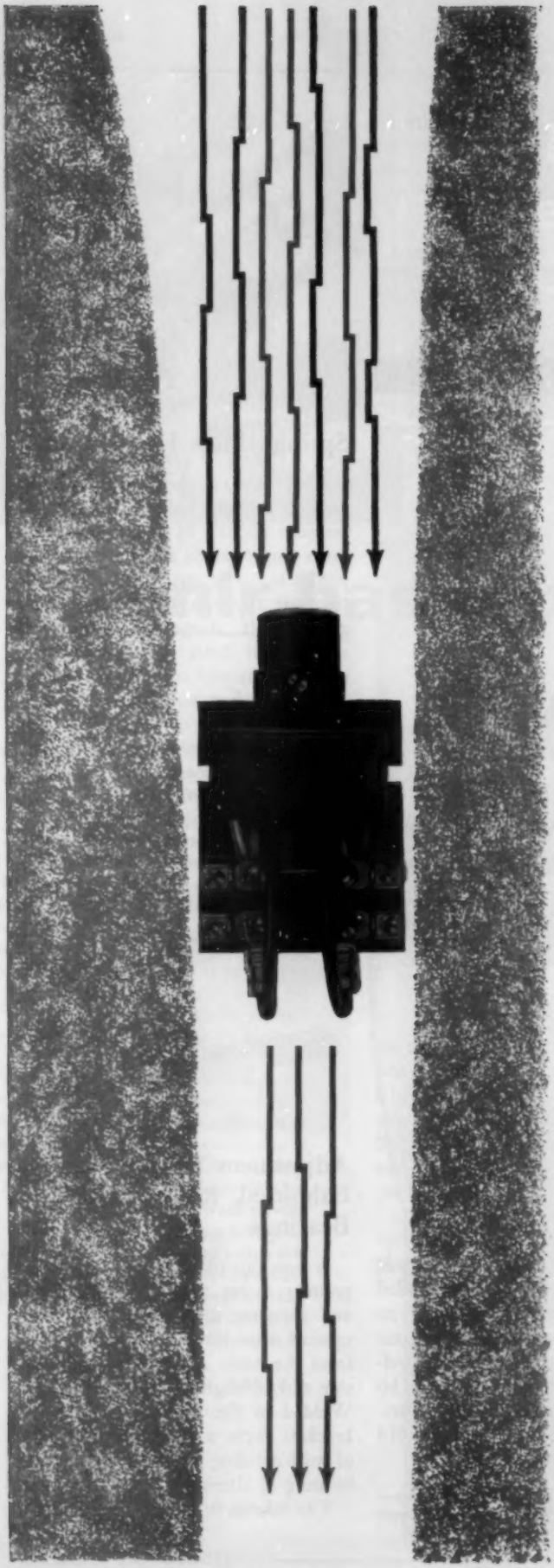


to protect equipment against overloads

use Adlake mercury relays

The new Adlake Mighty Midget relay, like *all* Adlake relays, requires no maintenance whatever . . . is quiet and chatterless . . . free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect its operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking.

Write for catalog and information.

The Adams & Westlake Company
Established 1857 • Elkhart, Indiana • New York • Chicago

Adlake 98th year

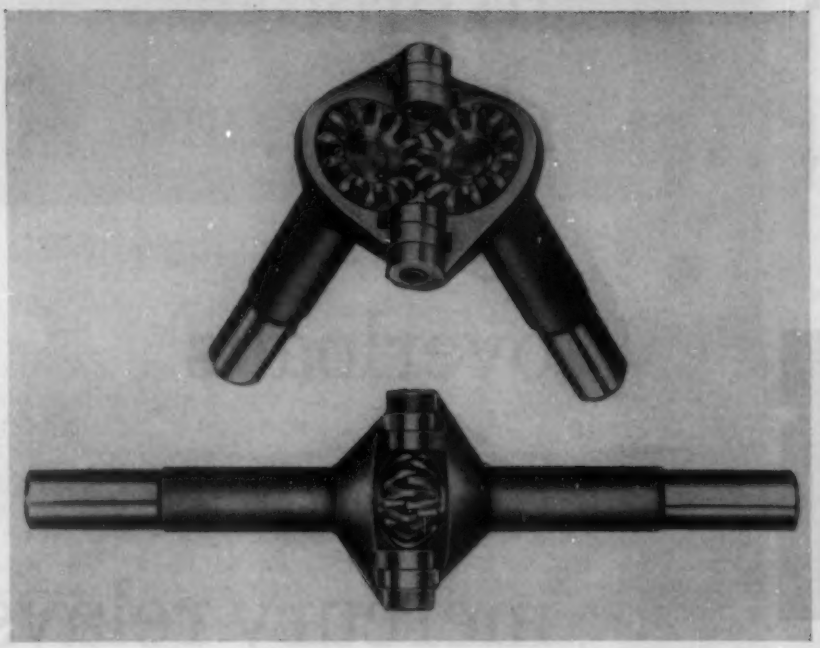
the original and largest manufacturers of mercury plunger-type relays

tator, beryllium copper springs, and an aluminum body. Governors are factory set to regulate at any one desired speed, from 6000 to 21,000 rpm. The setting of this new motor control is adjustable to ±2 per cent.

Length of the governor is ½ in.; commutator width, 3/32 in.; commutator diameter, ⅜ in. OD; clearance diameter, 1 in. The unit takes a ⅛ in. shaft. Nader Mfg. Co., 2661 Myrtle Av., Monrovia, Calif.

For more information—
Circle 9, inside back cover

MECHANICAL COMPONENTS



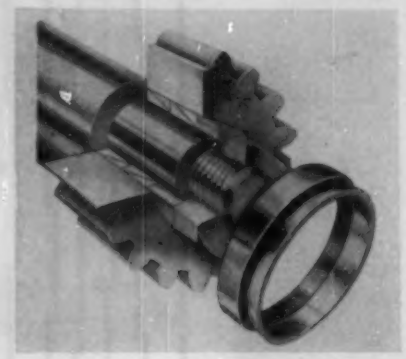
Hinged Gear Joint

A hinged gear joint is said to carry shaft-transmitted power around corners with ease. The maker of the joint claims that it operates in most applications where power must be "angled" to any position from 3 deg away from a straight line to 140 deg away from a straight line. Furthermore, there is no need to shut off or reduce the speed of the power transmission.

Produced originally as a component to be used in the remote control of glass bottle-making equipment, the joint as currently made is designed for use on three shaft sizes, 7/16, ½ and 5/8 in., and with an overall length of 10¼ in. Primary link in its power train are two bevel gears which have been modified to mesh smoothly and consistently through the full 137 deg arc, despite a constantly changing relationship between the pitch line and the axis of each gear. When in a fully "closed" position (when the axis is only 3 deg from a straight line), all teeth in these unusual gears are meshed. In the fully open position, four teeth are engaged.

Housing for the unit is a drop-forged and heat-treated section made in two parts. Although intended primarily for use on hand-operated remote controls, the new hinged gear joint is also suited to use on out-of-line power transmissions up to ¼ hp at speeds not exceeding 1750 rpm. Gray & Prior Machine Co., 614 Windsor St., Hartford, Conn.

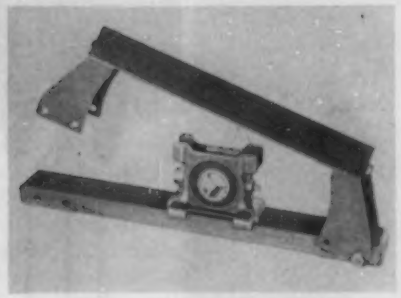
For more information—
Circle 10, inside back cover



Spring Holds Hub on Shaft

This German-designed device is wedged between hub and shaft under pressure applied by hand tools. The outer ring expands and the inner ring contracts. The assembly is said to transmit the maximum torque for a given shaft diameter because full strength of both hub and shaft is utilized. The unit consists of a straight cylindrical shaft and hub bore, eliminating all stress concentrations, permitting liberal tolerances on simple cylindrical surfaces. U.S. Automatic Corp., Amherst, Ohio.

For more information—
Circle 11, inside back cover



Adjustment Takeup With Babbitted, Roller or Ball Bearings

A new one-piece hinged top frame permits access to the bearing block and adjusting screw. The top swings upward after three bolts are removed from the base. A new arch-frame design adds strength to the end brackets. Welded to the top cover angle, the brackets form a rigid frame capable of withstanding heavy loads without twisting or altering bearing alignment.

The takeup is interchangeable with

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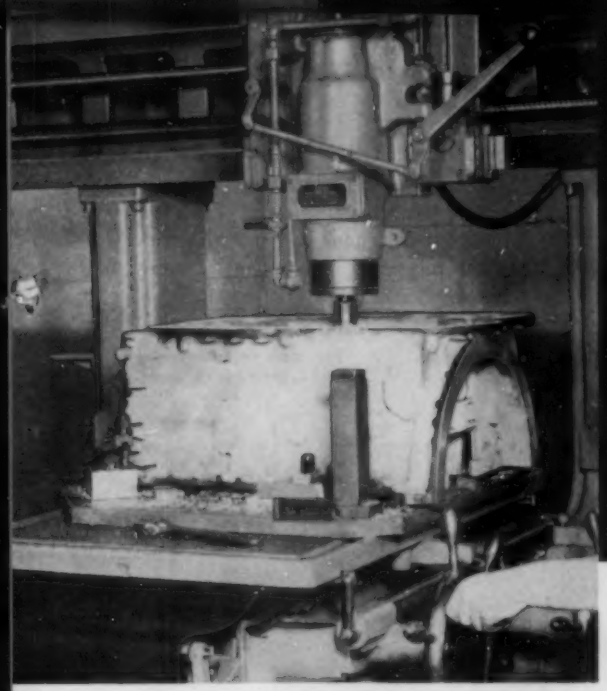


If limits are measured in .0001ths

chances are

Fafnir has a bearing on it

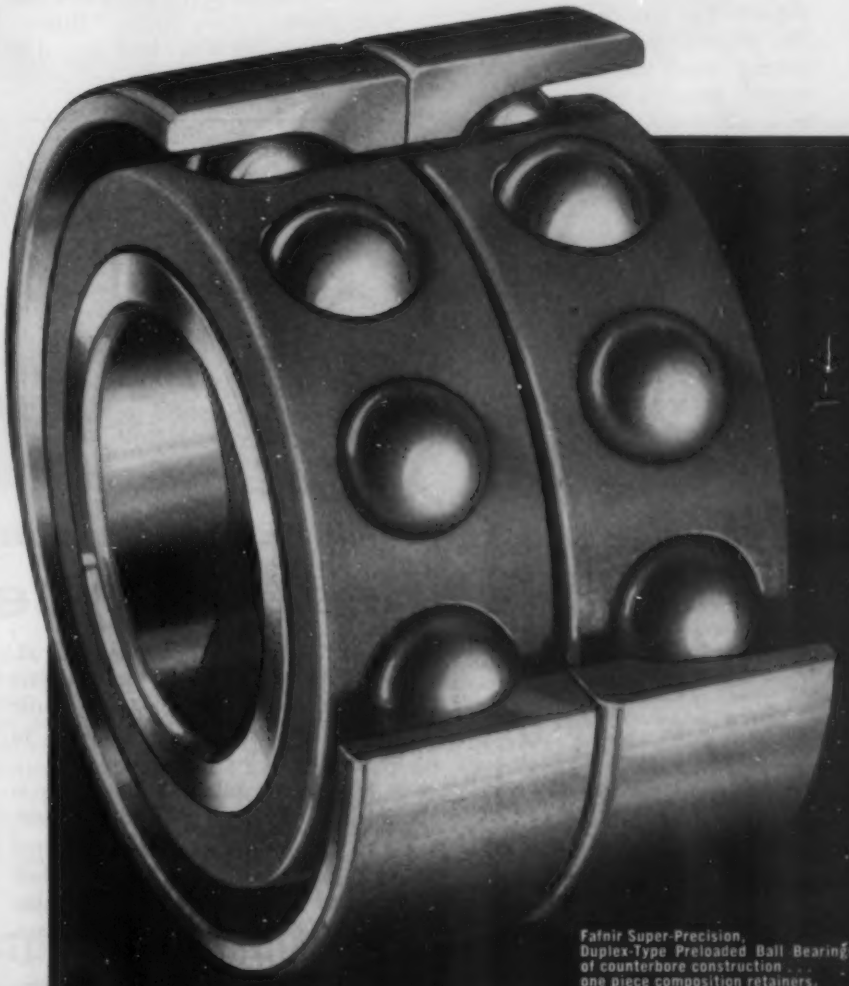
Precision designing and construction of the spindle head illustrated make possible extremely accurate profiling or milling at twelve operating speeds ranging from 260 to 6200 rpm. Design specifications include four pairs of Fafnir Super Precision Ball Bearings on the spindle shaft. These "jewels of industry" provide the ultimate in axial and radial rigidity. They run cool under exacting conditions of load and speed . . . conserve power . . . need no adjustment . . . and are permanently grease-packed.

It's in places like this where limits are in .0001ths that you find Fafnir Super-Precision Bearings . . . because they are *manufactured* in a separate super-precision department to the highest standards of dimensional control . . . in a wide range of sizes and types. There could be no better example of the "attitude and aptitude" of Fafnir engineers toward solving bearing problems.

If bearings are important to you, a few minutes spent with a Fafnir representative may help you get the right answer quickly.

The Fafnir Bearing Company,
New Britain, Connecticut.

MOST COMPLETE LINE IN AMERICA



Fafnir Super-Precision, Duplex-Type Preloaded Ball Bearings of counterbore construction . . . one piece composition retainers.

FAFNIR BALL BEARINGS

previous designs for use on a wide variety of materials handling equipment such as apron, belt, chain, drag, flight and slat conveyors, providing a positive means of adjustment.

The takeups are available with babbitted, ball or roller bearings. The bearing blocks have a longer base for added stability, and they are interchangeable with previous designs. Babbitted blocks have pipe top for grease cup or fitting. Ball or roller bearing blocks come with hydraulic type fittings. Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

For more information—
Circle 12, inside back cover

Medium Duty Ball Bearings

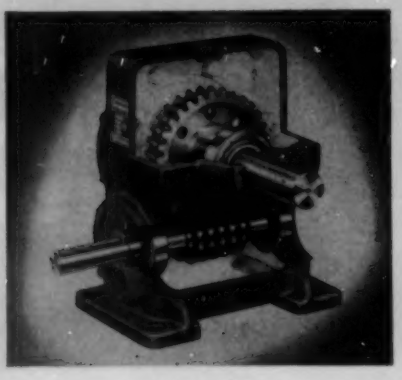
This line includes both ball bearing pillow blocks and ball bearing flange cartridge mounts. Full self-alignment is said to be provided by the spherical outer race of the ball bearing inner unit, which fits accurately into the spherical seat in the semi-steel housing.

Metallic-backed synthetic seals are mechanically anchored in position and will not blow under grease gun pressure. The lubricant is effectively sealed in; dust and dirt are excluded. A locking pin prevents rotation of the outer bearing race while allowing full self-alignment. The bearing is securely locked to the shaft by means of two set screws through the collar at 120 deg. These ball bearings are completely assembled, factory adjusted, pre-lubricated and ready to mount on the shaft. Both the pillow blocks and flange cartridge mounts are available from stock in popular transmission sizes. Dodge Mfg. Corp., Mishawaka, Ind.

For more information—
Circle 13, inside back cover

Speed Reducers of 0.018 to 34.14 Hp

A line of speed reducers comprised of nine models available in a total of 108 sizes has been announced. Models include single reduction—worm gear type; double reduction—worm gear type; double reduction—worm and



helical gear type. The horsepower range is from 0.018 to 34.14 hp, with a ratio range of 5:1 to 4460:1 and a maximum output torque range of 103 to 34,767 in-lb.

The manufacturer claims that increased horsepower and torque output, and greater overhung load capacity has been achieved as a result of increasing diameters on both the input and output shafts. Also, larger, stronger tapered roller bearings have helped to increase the load carrying capacity. A newly designed housing provides greater thermal capacity and a more secure, vibrationless mounting. Winsmith, Inc., Springville, N. Y.

For more information—
Circle 14, inside back cover

Gearless Differential

Designed for applications where minimum backlash is required, the Model T751 makes use of precision balls instead of conventional planetary

Extra-Heavy Duty Flexible Shaft

Heart of this shaft is a core 1¼ in. dia. This core is made up of layers of tightly wound high-grade music wire. This shaft can transmit up to 1650 in-lb of torque at 440 rpm.

The heavy duty flexible casing is lined with oil tempered spring steel, reinforced with wire braid, covered with oil-resistant impregnated fabric and an abrasion resistant rubber jacket. The casing serves as the bearing surface for the core and also retains the lubricant. If desired, extra reinforcement can be put on one end as shown.

The new shaft is provided with steel-backed bronze sleeve bearings at each end, which allow the core to float inside the casing. Couplings of various bores are available for connecting up at each end. Also, on applications where there is apt to be a change in length of the drive, square slip joints, 18 in. long, are available for connection at one end of the shaft. Stow Mfg. Co., 426 State St., Binghamton, N. Y.

For more information—
Circle 15, inside back cover

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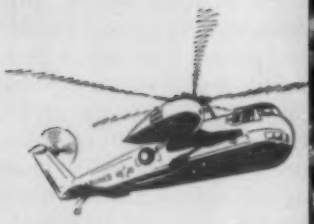
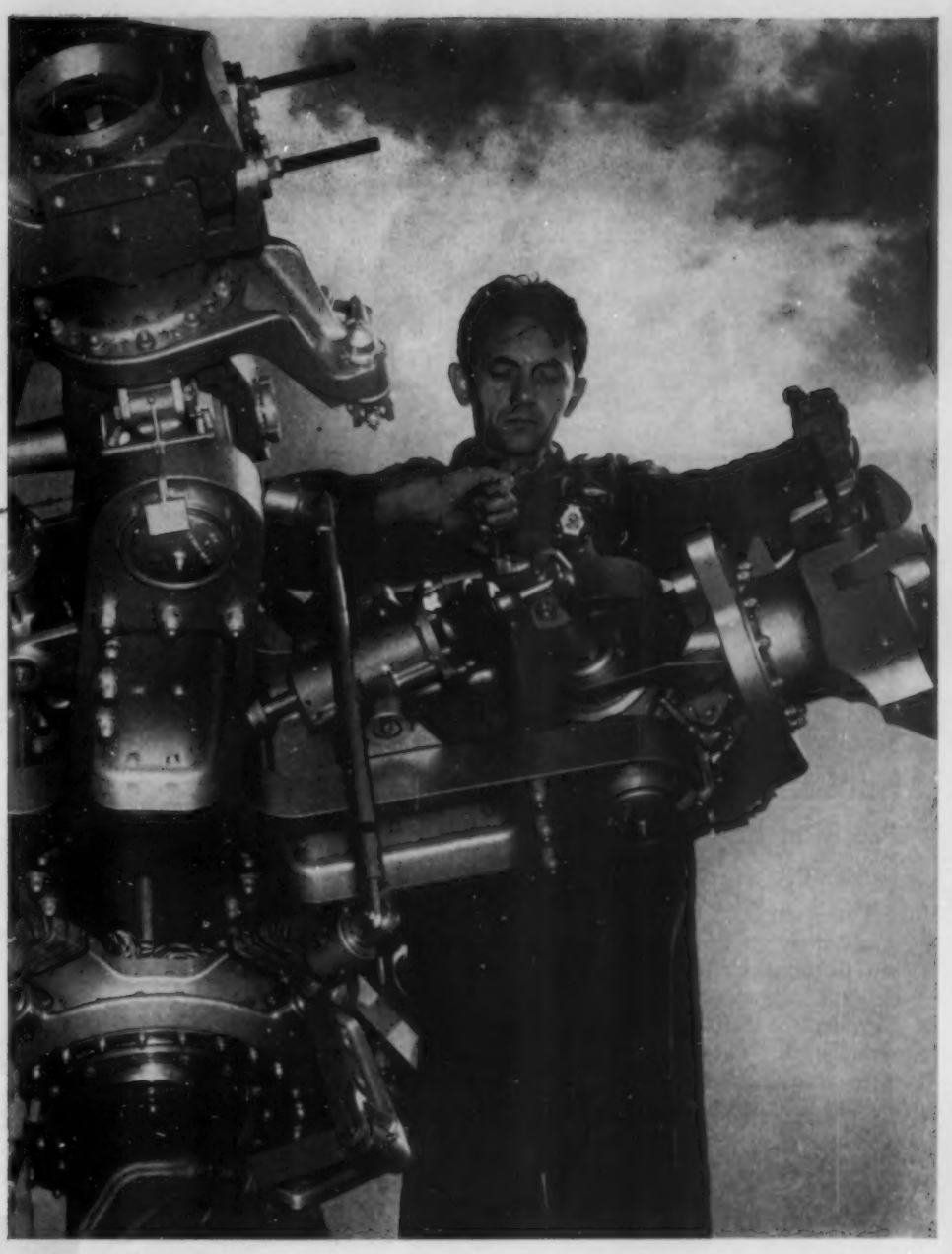




Sikorsky rotor heads stress ESNA

A 16-year fastener field test

How many different stresses are exerted on this rotor head as it controls the cyclic and collective pitch of the five main blades of the Sikorsky S56 designed to transport 26 fully equipped troops? Since it also transforms engine power into forward motion or vertical flight, the stresses add up to an interesting but complicated problem in dynamics. Notice that Sikorsky has solved the fastening problems related to this rotor head design with dozens of standard hexagon and double hexagon Elastic Stop nuts.

They are self-locking, maintain precision adjustments and assure fastener security under the vibration and stress loads normal to helicopter flight.

Sikorsky Aircraft Company had been using Elastic Stop nuts for over a decade before it began developing rotary wing aircraft in 1939. They have been a steady ESNA customer for 27 years and Elastic Stop nuts have been a standard fastener on every new Sikorsky design.

If you recognize the practical value of almost three decades of "flight tested" experience on all types of air frames and engines . . . you'll rely on Elastic Stop® nuts.

ESNA®

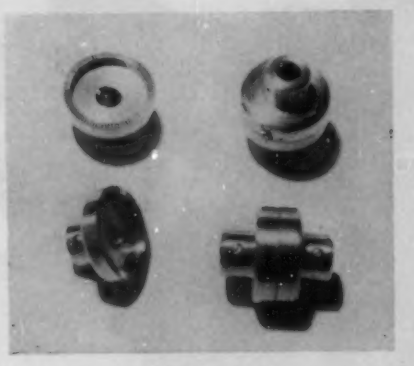
ELASTIC STOP NUT CORPORATION OF AMERICA

Department N83-102 • 2330 Vauxhall Road • Union, New Jersey

gears. The balls and plate upon which they ride are made of tungsten carbide and are lapped to insure accuracy.

The unit is installed in a servo-type case. Both input gears are accessible through slots in the side of case. Sterling Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.

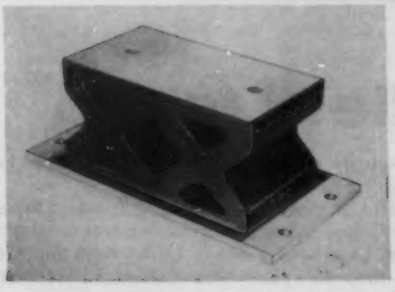
For more information—
Circle 16, inside back cover



Precision Multi-Jaw Coupling

These stainless steel couplings are immediately available from stock and can be used where manual or mechanical engagements and disengagements of shafts or unit assemblies are required. They are designed for three basic shaft sizes: $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. dia. Pic Design Corp., 160 Atlantic Ave., Lynbrook, N. Y.

For more information—
Circle 17, inside back cover



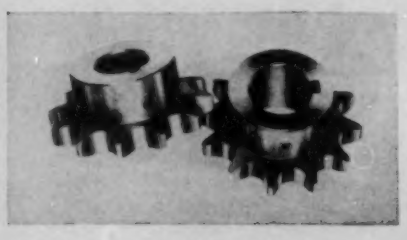
Lattice-Type Vibration Mounting

These bonded-rubber lattice mountings are said to provide a high degree of vibration and noise isolation, particularly in the low-frequency, high-amplitude range. This new mounting is being produced with capacities ranging from 250 to 3000 lb and static deflections from $\frac{1}{4}$ to $1\frac{1}{2}$ in. Bonded-rubber lattice mountings have been used successfully in the past to isolate vibrations from vibrating screens, vibrating conveyors, foundry shake-outs, generators, food processing equipment, air conditioning compressors, shipboard equipment and others. Lord Mfg. Co., 1635 W. 12 St., Erie, Pa.

For more information—
Circle 18, inside back cover

Roller Chain Sprockets

Finished bore roller chain sprockets that can be installed without reworking are now available for immediate delivery. They are offered in Type B single widths. They are made of high carbon steel, ready for hardening, and come in a wide range of popular sizes. Bores range from $\frac{5}{8}$ to $2\frac{7}{16}$ in., while the number of teeth per sprocket range from 10 to 24 in., $\frac{1}{2}$ through 1 in.



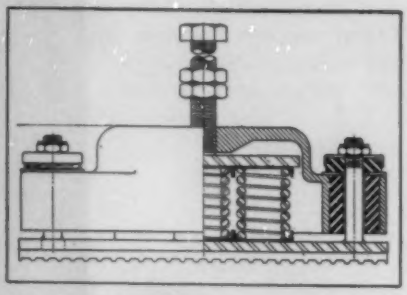
pitch. All sprockets are complete with keyway and setscrew. Manufactured to conform with ASA specifications, the sprockets are interchangeable with all other standard, single-width, roller chain sprockets. Morse Chain Co., Ithaca, N. Y.

For more information—
Circle 19, inside back cover

Heavy Duty Vibration Mountings

These mountings consist of a cast semi-steel housing containing helical steel springs, rubber thrust bumpers, nylon dampers and a steel base plate with sway control assemblies. A dual-purpose bolt secures the mounting to the machine and provides leveling.

Nylon-lined, pre-compressed, cylin-



drical rubber bumpers absorb thrust in any horizontal direction. The nylon liners protect the rubber from abrasion and thus assure a constant degree of stiffness. Because of the low-friction characteristics of nylon, an unusually high degree of thrust control is said to be obtained without any undue increase in vertical stiffness.

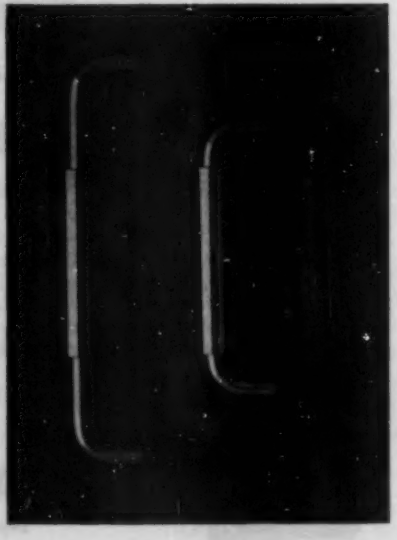
The line consists of 41 standard sizes, ranging in rated load capacity from 100 to 6500 lb with higher load capacities available. T. R. Finn & Co., Inc., Hawthorne, N. J.

For more information—
Circle 20, inside back cover

Adjustable-Length Handles

This handle has adjustable center spacing $3\frac{1}{4}$ to 6 in. On special orders, an unlimited maximum center spacing can be furnished. Height above panel can vary from $1\frac{7}{16}$ to 2 in.

Handles are made of brass and are nickel plated. They are also available unplated or can be plated in any finish



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SKF
makes them ALL
Because SKF makes ball and roller bearings of many types and sizes, SKF serves all industries. That is why you get unbiased advice based on exceptionally broad experience when SKF's unmatched product-assistance staff helps you put the right bearing in the right place in your product.
SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
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SKF®
BALL AND ROLLER BEARINGS
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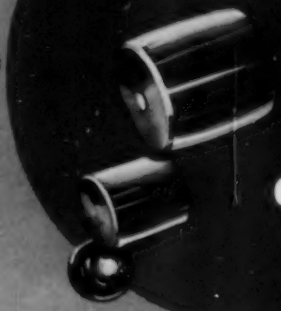
#1 IMPROVED SPHERICAL ROLLER BEARING...

Size for size, more capacity and longer life than any other spherical roller bearing. Introduced by SKF two years ago; now available in the popular series. Already adopted by hundreds of leading manufacturers.

#2 HIGHER CAPACITY CYLINDRICAL ROLLER BEARING...

With crowned rollers and cylindrical raceways, engineered for today's high speed—high load applications. Available with flanged or flangeless rings to meet design requirements.

Four of the Many SKF QUALITY PRODUCTS



#3 "SY" UNIT PILLOW BLOCK WITH SUPERIOR BEARING SEAL...

Red Seals, of DuPont "Fairprene", team with a rotating flinger to exclude dirt and retain lubricant. The "SY" Pillow Block is easy to mount—just slide unit on shaft, tighten two set screws. And the "SY" is interchangeable with existing installations.

#4 QUIETER RUNNING SINGLE-ROW DEEP GROOVE BALL BEARINGS...

With proven SKF Red Seals which keep dirt out and lubricant in. Available with any of 13 combinations of Red Seals, shields and snap-rings.

To Get The Most Valuable Book You Ever Had...

Catalog #350 – Complete technical and engineering data on SKF's complete anti-friction line. Send for your copy to **SKF INDUSTRIES, INC.**, PHILADELPHIA 32, PA.— *manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

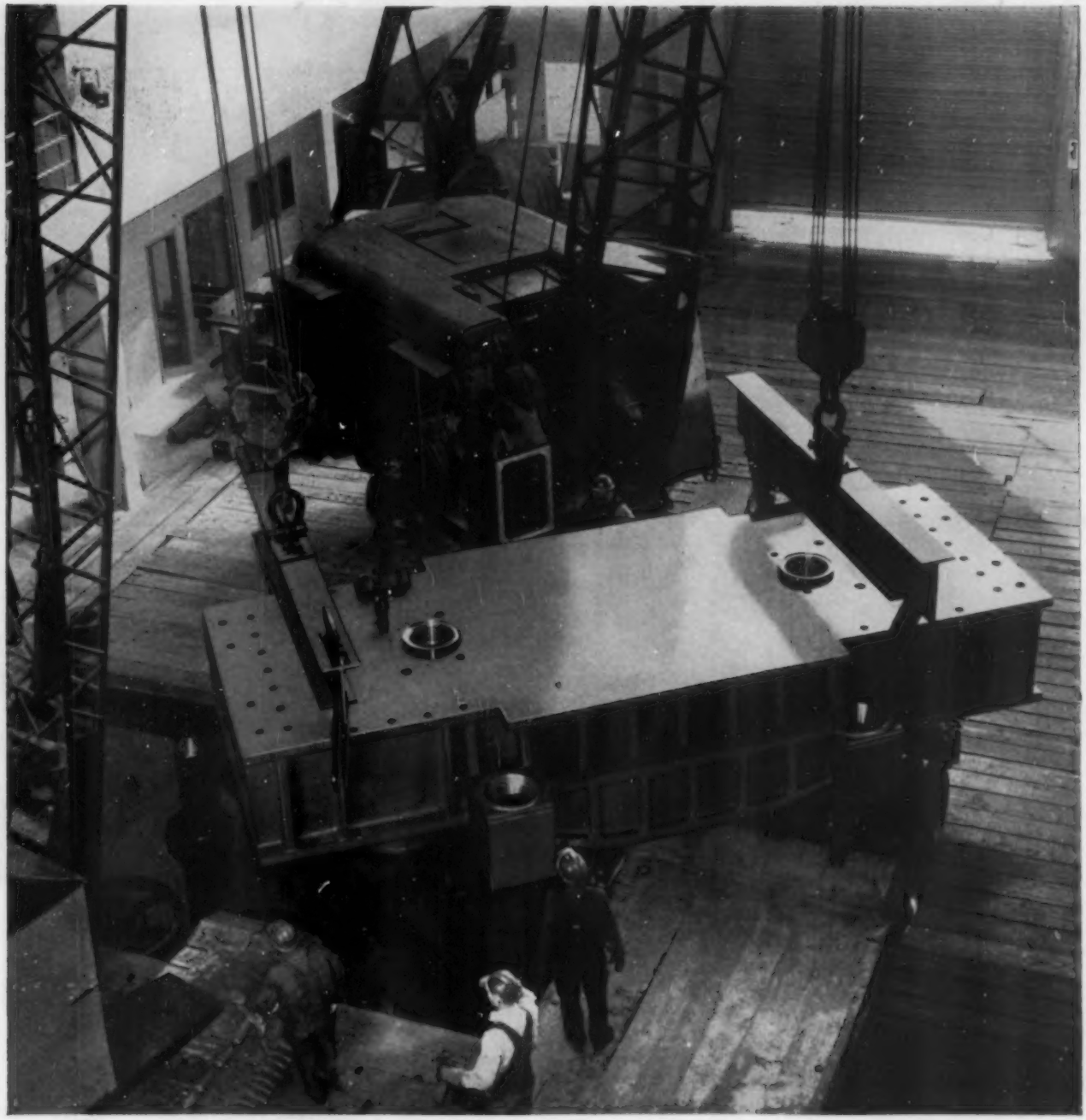
7802-A
FORM 410

SKF®

BALL AND ROLLER BEARINGS

See idea for design engineers on other side.

© 1955 SKF Industries, Inc.



BED PLATE FOR WORLD'S LARGEST TESTING MACHINE

Here being positioned on its supports is the bed plate for the new testing machine at Lehigh University's Fritz Engineering Laboratory. Fabricated by Baldwin-Lima-Hamilton Corporation, the machine's capacity of 5,000,000 lb and sizes of specimens it can handle make it the world's largest universal testing machine. Obviously strength was a vital requirement in the steel for the bed plate. So was weldability, for the plates in the weldment range up to 3½ in. in thickness. Mayari R low-alloy, high-strength steel was chosen for this gruelling service. Not only is Mayari R 50 pct stronger than carbon structural steel but it is actually easier to weld in heavier plate thicknesses. Catalog 353 tells the Mayari R story in full. If you would like a copy, just write our nearest office.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Mayari R makes it lighter... stronger... longer lasting

desired. They are available with or without ferrules and are furnished in ⅛ in., No. 18 thread. They are supplied with or without nuts and washers. U. S. Engineering Co., Inc., 521 Commercial St., Glendale 3, Calif.

For more information—
Circle 21, inside back cover

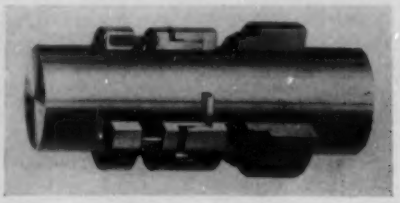
Filter-Lubricator for ¼ and ⅜ in. Pipe

Oil is always present in the air stream in this unit and accordingly there is said to be instant response to sudden demand changes. The moment air flows through this unit oil moves with it. The unit has no oil tubes, needle valves or syphons to cause lag in oil movement. This instantaneous oil flow is readily adjusted by turning the control on top of the lubricator. This control raises and lowers a porus metal oil feed wick as well as varying the size of the venturi which governs the air velocity around the wick. Both air and oil are filtered and both filters are permanent and re-usable. The filter unit of the filter-lubricator has a built-in automatic cleanout which drains all collected moisture when the air line pressure if off. Nu-Jett Products Corp., 1355 Michigan N. E., Grand Rapids, Mich.

For more information—
Circle 22, inside back cover

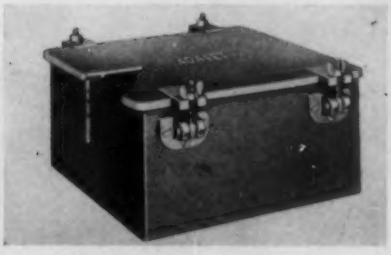
High Temperature Rotary Mechanical Seal

This seal is said to be successfully handling hot oils or hot water at temperatures up to 800 F. Construc-



tion generally is of stainless steel, with stainless U-ring shaft packings. Design allows for thermal expansion. The seals do not require stuffing box flushings, unless to control vapor pressures in the box, or to flush out any excessive coke formation which might be encountered in high temperature applications. Durametallic Corp., 2104 Factory St., Kalamazoo, Mich.

For more information—
Circle 23, inside back cover



Cast Aluminum Weatherproof Enclosure

This hinged cover container is available in sizes ranging from small ones to one that is 24 x 36 x 12 in. Adalet Mfg. Co., 14300 Lorain Ave., Cleveland 11, Ohio.

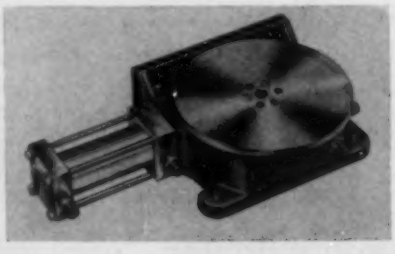
For more information—
Circle 24, inside back cover

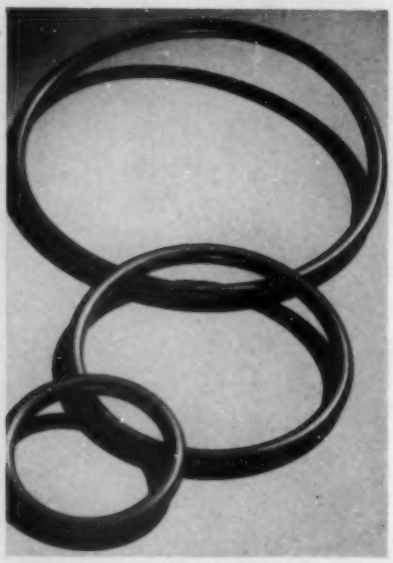
Indexing Feed Tables

Guaranteed against over-ride and capable of indexing on 24 indexes at 300 sps with a 40 lb load on top of the 7¼ in. dia plate, these tables are designed for use in areas where space is limited. A 10 in. dia plate is optional.

Mounting is provided for either horizontal or verticle application and compressed air is available through the center stud for actuation of secondary equipment. The tables can be set for either 4, 6, 8, 12 or 24 indexes per revolution and special indexes are available on order. Accuracy is said to be ±0.001 in. at the periphery of the standard top plate. A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

For more information—
Circle 25, inside back cover





Hydraulic O-Rings For –65F to 275F

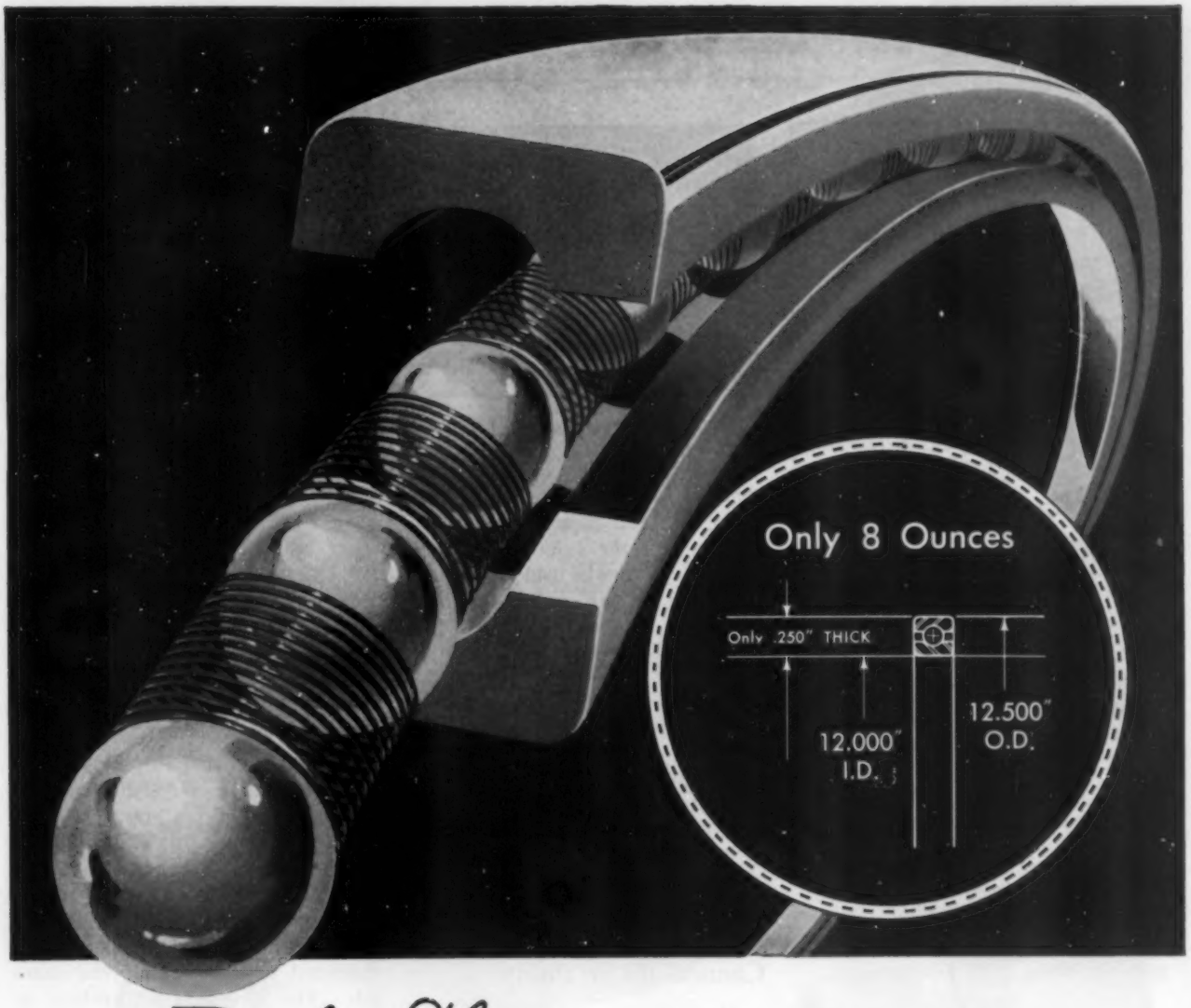
The compond these rings are made from was developed expressly to meet functional and physical requirements such as those included in MIL-P-18017. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information—
Circle 26, inside back cover

Slabbed Head Self-Locking Set Screw

For applications in which the slab portion cannot extend beyond the tapped hole, this set screw is said to provide a positive locking action that is effectively retained in all positions.

CONTINUED ON PAGE 228



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54 RS.

***Reali-Slim* Ball Bearings** — In Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

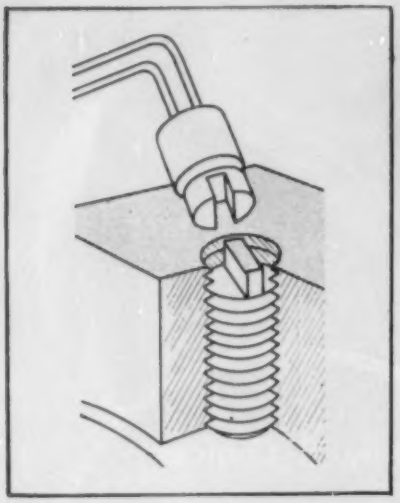
K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

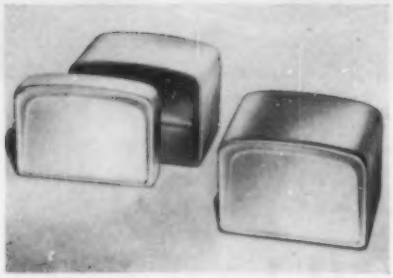
All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings



Also, being flush with the surface, the screw becomes practically tamper-proof as well as resistant to accidental removal. A special wrench is provided to use when removal is desirable. Set Screw & Mfg. Co., Main St., Bartlett, Ill.

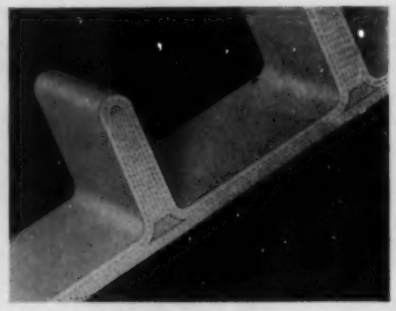
For more information—
Circle 27, inside back cover



Aluminum Cases

A line of drawn aluminum instrument cases for electronic and instrument manufacturers is 11 x 7¾ in. high with depth varying, as ordered, from 4 to 8¾ in. These cases are furnished in any quantity from one to thousands without tooling cost, and shipment can be made within two weeks of receipt of order. Additional operations, such as piercing holes in the front cover for meter, dial or cable openings, additional dimples, chassis slides, fasteners or finishing, can also be done by this manufacturer. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

For more information—
Circle 28, inside back cover



Cleated Conveyor Belt

A cleated conveyor belt for incline or decline conveying has no joints, cracks or gaps. The cleat and the body of the belt are one solid piece. Cleats can be made any height, width and spacing, and as stiff or as flexible as desired. They will flex around pulley diameters, compatible with weight of the belt.

Colors available are white, tan or black. They can be supplied in rubber, neoprene or special compounds for resisting grease, oil, juices, chemicals. A. J. Sparks Belting Co., 867 Grandville Ave., S.W., Grand Rapids, Mich.

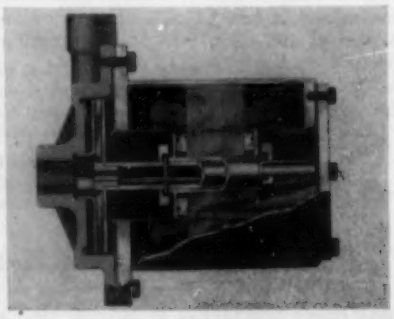
For more information—
Circle 29, inside back cover

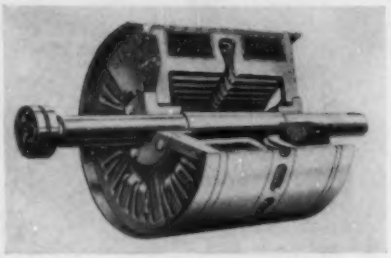
Canned Rotor Pump

These ¼ through 3 hp leakproof units use fabricated parts in their construction which can be clad with such metals as titanium, zirconium and Hastelloy series metals, as well as Monel, Carpenter 20 and the various types of stainless steels previously available. Approximately 400 per cent more bearing area is said to be provided by the bearings developed for this series. These bearings are semi-floating and can be replaced from front or rear of the pump without special tools and without breaking piping connections.

Capacities to 170 gpm and heads to 150 ft are available. Standard temperature and pressure limits are 350F and 150 psi. Chempump Corp. Station H, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

For more information—
Circle 30, inside back cover





Two-Coil Magnetic Pulley

It is claimed that this two-coil design produces a more effective flux pattern with a deeper magnetic field at the center of the pulley, a pattern which conforms to normal conveyor load conditions. In many applications it is possible to install a two-coil pulley of smaller diameter than a three-coil pulley handling the same job. The two-coil construction is available in a variety of widths and diameters ranging from 12 to 60 in. Stearns Magnetic, Inc., Milwaukee 46, Wis.

For more information—
Circle 31, inside back cover

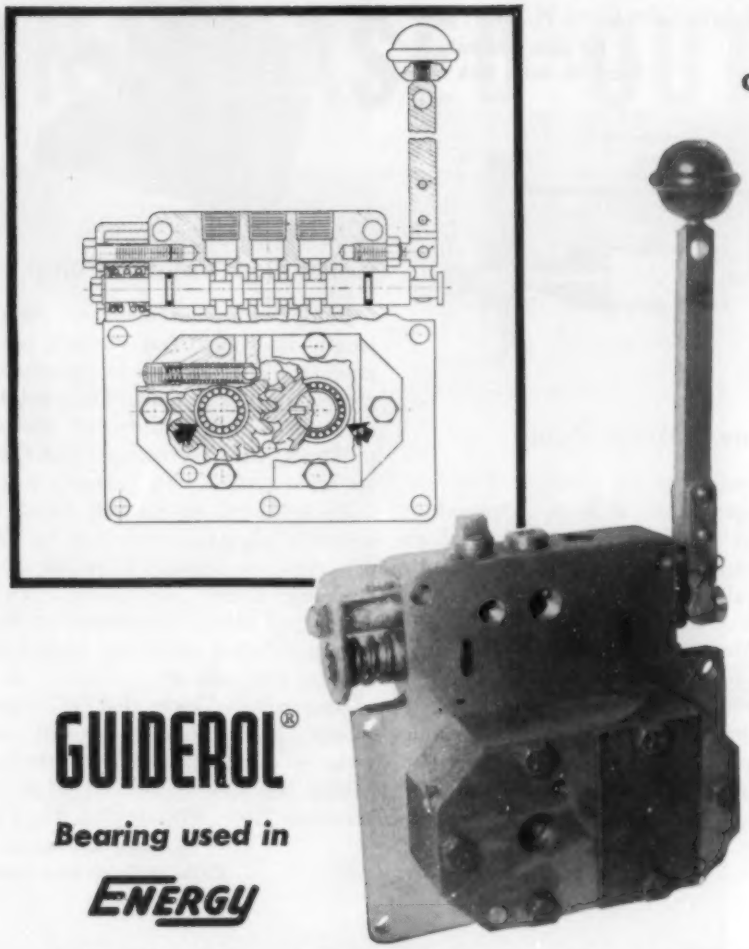
Oil-Free Air Pressure Pump

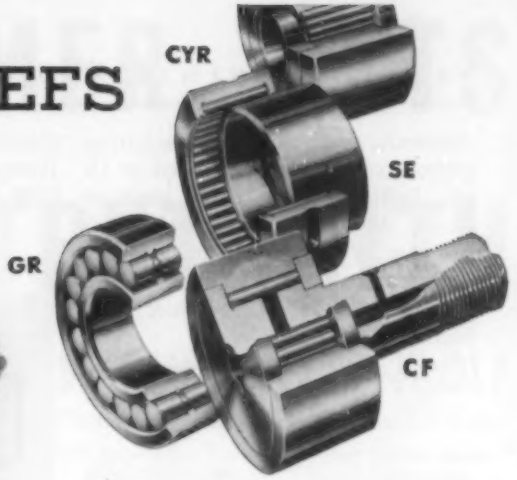
An integral motor-pump unit for equipment requiring automatic pressure up to 20 psi has both motor and pump on a common shaft. No seals or shaft packings are used. Self-lubricating thrust plates and blades of carbon-graphite composition take up wear automatically. Oil-free pump impeller parts are assembled on the end of the armature shaft.

Pump displacement is 0.304 cu in per rev. Rated capacity of the pump is 550 cu in per min free air delivery at 20 psi discharge pressure under standard sea level inlet conditions.

CONTINUED ON PAGE 230

McGILL BEARING BRIEFS





GUIDEROL®

Bearing used in

ENERGY

hydraulic pumps for attachment to farm tractors

OUTWEARS PREVIOUS BEARING 15 to 1

The great load-carrying capacity and the compact size of the Guiderol Bearing are the principal reasons why Energy Farm Equipment Company of Monticello, Iowa, uses the Guiderol for gear support bearings in its hydraulic pump.

Energy reports, "We are one of the largest manufacturers of hydraulic pumps used as attachments to farm tractors . . . Our production is approximately 10,000 units a year and we owe much of our success to the excellent performance of the McGill Bearings used."

The report adds the overall product is improved because closer tolerances can be maintained, maintenance is reduced to zero and length of life is 15 times that of the bronze bearing previously used.

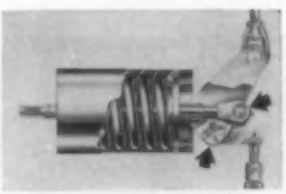
BEARING SELECTION GUIDE

A revised 140 page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Company. Ask for Catalog No. 52.

MARION HOISTS HANDLE HEAVIER LOADS WITH GUIDEROL® BEARINGS

Marion Heavy-Duty Hydraulic Hoists are built to "handle heavier loads with faster action" while withstanding extreme abuse. Four Guiderol GR-20 Bearings, used as gear support bearings in the pumping mechanism for these dump bodies, have the capacity and dependability for trouble-free operation under these tough operating conditions.

CAREFUL MATERIAL SELECTION DICTATES GUIDEROL® BEARINGS FOR NAVCO COUNTERPOISE HANGERS



In its Counterpoise pipe hanger, National Valve and Manufacturing Company uses the best and most durable materials to enable it to carry loads up to 16,000 pounds and travels up to 12 inches. The entire hanger is designed to take advantage of the Guiderol capacity and performance.

50th McGILL Anniversary

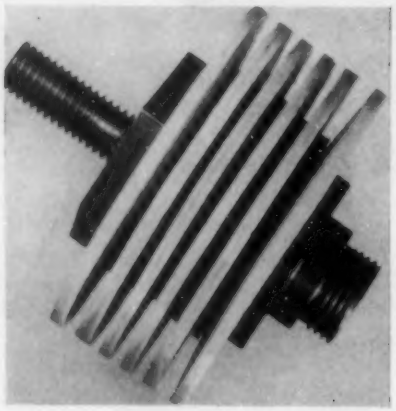
Insure performance with McGILL® . . .

MULTIROL®—GUIDEROL®—CAMROL full type roller bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

Automatic shut-off under increasing pressure conditions is provided at 18 psi. Relief valve is set to crack at 22 psi. Motor is ⅛ hp, at 3450 rpm, 115 v, ac, 4 amp, 60 cps single-phase, continuous duty. Weight is 36.82 pounds. Lear, Inc., Lear-Romec Div., Elyria, Ohio.

For more information—
Circle 32, inside back cover



Porous Fluorocarbon Filters

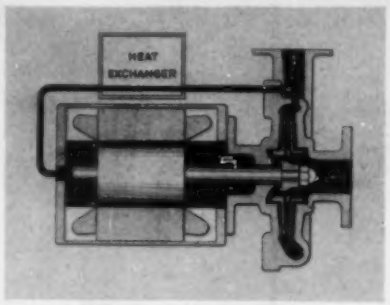
These porous fluorocarbon filters are of all-welded construction with molded flow passages and are designed for easy disassembly and cleaning. A square foot of filter area is contained in a volume 2 in. high and 3½ in. OD. Porous Plastic Filter Co., Glen Gove, N. Y.

For more information—
Circle 33, inside back cover

Filter Cartridge of Glass Fibre

These filter cylinders are being offered in 2, 10, 25 and 50 micron grades. Each cylinder is lined with fiber glass cloth to insure lint-free filtration and has variable density. Porous Plastic Filter Co., Inc., 30 Sea Cliff Ave., Glen Cove, N. Y.

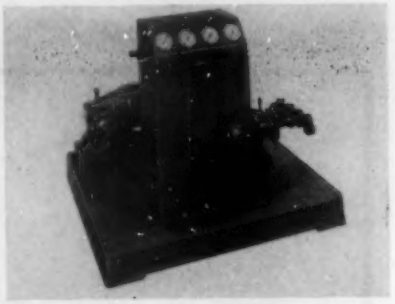
For more information—
Circel 34, inside back cover



Canned Motor Pump

Combining an integral heat exchanger with a high temperature pump design, this pump is said to be capable of handling Dowtherm, Arochlor, hot fats, hot oils and similar fluids at temperatures as high as 1000 F. Model CHS pumps are available in 5 and 7½ hp sizes and Model CFT units in ¾ and 1½ hp. Maximum head developed is 195 ft and maximum capacity is 250 gpm. Chempump Corp., Station I, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

For more information—
Circle 35, inside back cover



Controlled Volume Pump

Pump with instrument air stroke length adjustment has recently been made available for use in pneumatic process control systems. Designed to solve specific low capacity flow control problems, the new pump utilizes an air servo system with feedback loop.

Stroke length of the new pump is infinitely adjustable from zero to 100 per cent of full length by means of a reversible rotary air motor. This motor and other components of the pneumatic servo system are housed in a 22-in. high cabinet.

Sensitivity is such that 1/70 psi change in instrument control air pressure causes re-setting of stroke. Milton Roy Co., Station N, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

For more information—
Circle 36, inside back cover

ELECTRIC POWER, CONTROL

Small Magnetic Counter

For moderate counting duty, on applications where extreme long life is not required, this reset magnetic counter can be connected in series with any device having a contact arrangement. It may be actuated by any type of switch, relay or photoelectric unit.

Maximum recommended speed is 700 counts per minute. Power consumption is 4.5 w at rated voltage (24 and 110 v, a-c–d-c types are standard). Voltage variation is permissible up to 10 per cent but not more than 10 v. Counter measures 2¼ x 2½ in. high. Standard counter

CONTINUED ON PAGE 232

AUTOMOTIVE MFR. GETS INCREASED OUTPUT WITH

STERLING SPEED-TROL!

Through use of Speed-Trols we can utilize the full productive capacity of our Sheridan cutting and forming presses. Because of Speed-Trol's infinite speed adjustment and accurate speed regulation our presses can accommodate the wide variety of types and thicknesses of materials which we use and for which the presses were designed, reports J. Vallance, of Arvey Corp., Detroit, manufacturers of automotive products.

STERLING SPEED-TROL GIVES YOU VARIABLE SPEED CONTROL NECESSARY FOR:

EQUIPMENT ADAPTATION TO: Sequence synchronization—operators' abilities—load variations due to differences in quantity, quality, weight, size, tension, hardness or shape of material to be processed, machined, conveyed, blended, mixed, etc.

PROCESS CONTROL OF: Temperature—viscosity—level—pressure—flow—etc.

TIME CONTROL OF: Baking—drying—heating—cooking—pasteurizing—soaking—chemical action—etc.

With Speed-Trol you get the maximum in production, plant efficiency, quality and profit.

OVER 60 ILLUSTRATIONS
showing how Sterling Electric Power Drives reduce production costs. Write for Bulletin No. 203-A

SEPARATE MOTOR SPEED-TROL DRIVE

For applications requiring separate motor and variable speed transmission.

STERLING ELECTRIC MOTORS

Plants: New York City 51; Chicago 35; Los Angeles 22; Hamilton, Canada; Santiago, Chile
Offices and distributors in all principal cities

has three figures but four may be provided on special order. Veeder-Root. Inc., Hartford 2, Conn.

For more information—
Circle 37, inside back cover

Five-Digit Electrical Counter

An electrical counter designed for high-speed impulse recording measures ¾ x 1⅝ x 4 1/16 in. Each counter is enclosed in a sturdy metal cover, available either as an individual unit or in strips of ten, with a common cover. A flexible spring clip holds each unit firmly in place on the mounting plate.

The mechanism of the counter is built so that the wheels cannot jam or get out of mesh. Each counter wheel is made of nylon. The coil of the unit is terminated with soldering lugs in rear. North Electric Co., Galion, Ohio.

For more information—
Circle 38, inside back cover

Miniature Recording Counter

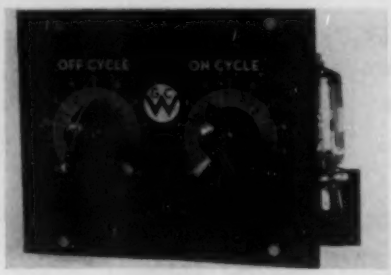
This instrument is capable of accepting pulses or contact closures at the rate of 1000 per min, this electromechanical recording counter may be furnished to facilitate actuation by a wide variety of input signals. Data is presented in sharp clear ⅛ in. high numerals on a 2¼ in. paper tape. It is also available in a card printing model.

Automatic reset is a standard feature. Printer may be actuated manually by pushbutton or automatically by signal. Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13.

For more information—
Circle 39, inside back cover

Repeat Cycle Timer

Typical applications for this timer include sign flashing, life testing, bag filling, refluxing and automatic weighing. An electronic circuit with two cold-cathode triodes is used. No warm-up is required and no filament



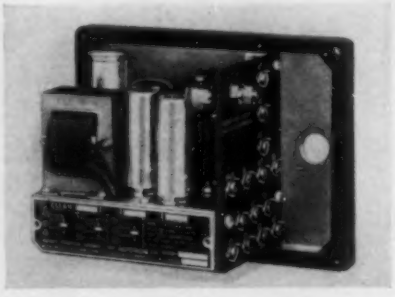
power is consumed. Independent adjustability of both on and off cycles from 0.1 to 12 sec is provided. Output is a single-pole, double-throw relay with 5 amp contacts. Timer is available for panel mounting or in a 3 x 4 x 5 in. box. G. C. Wilson & Co., 1915 8 Ave., Hutington W. Va.

For more information—
Circle 40, inside back cover

Timer and Programmer

This ten-speed unit (minutes to weeks) consists of a program disc (6 in. dia) and a number of cams and switches, according to the application. Adjustable cam arrangement gives from 5 to 95 per cent of the time cycle on or off at every one of the ten speeds. Gorrell & Gorrell, Haworth, N. J.

For more information—
Circle 41, inside back cover



Photoelectric Control

A photoelectric control for protective as well as repetitive type applications where the phototube normally sees light is announced. The plate relay energizes when the light beam is on the phototube and all tubes are operating. The relay de-energizes when the light beam is interrupted or when a tube filament fails or any tube loses emission, affording "fail-safe" operation for protective type applications such as smoke detection, level and limit controls, safety controls.

The Model F1A requires 5 ft-c min light, 0.125 min phototube light time and 0.025 min phototube dark time. The sensitivity adjustment is enclosed to prevent tampering and equipped with shaftlock to hold setting. Plate relay contacts are rated at 8 amp, 115 v, ac, non-inductive load. Autotron Co., Box 722-V, Danville, Ill.

For more information—
Circle 42, inside back cover

Relays With Integral Rectifiers

Increased operating reliability throughout the range 25 to 400 cps, ac, is said to be provided in these relays. Full-wave rectifiers incorporated in these relays convert ac to rectified dc, thus providing d-c operation from a-c power supply. Increased operating sensitivity, higher contact pressures, greater resistance to vibration, reliable operation through much wider variation in voltage or current, freedom from a-c hum and, in many cases, reduced size are claimed. The rectified relays are available with a wide range of contact combinations in hermetically sealed or dustproof enclosures as well as open. Magnecraft Electric Co., 3350Y W. Grand Ave., Chicago 51.

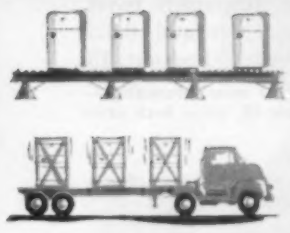
For more information—
Circle 43, inside back cover

Relay Operates at 10 Millisec

Available either hermetically sealed or with dust cover, this relay is designed for d-c applications in contact combinations from single-pole, single-throw to double-pole, double-throw. Capacity is up to 1.5 amp inductive and 5 amp resistive, with coil resistance to a maximum of 30,000 ohm. The bounce and chatter are eliminated by the built-in wiping action in the contact movement. Drop-out if desired can be adjusted to about 65 per cent of pick-up. Wattage re-

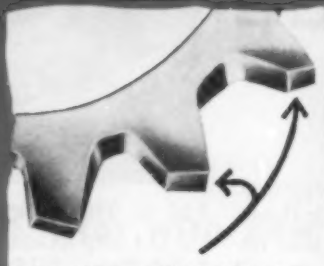
CONTINUED ON PAGE 234

Why SHAKEPROOF® LOCK WASHERS defeat vibration!

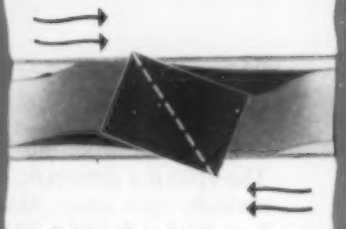


The purpose of lock washers is to keep screws and nuts tight.

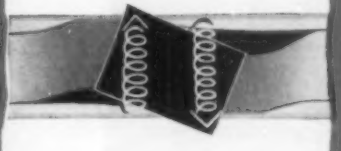
Shakeproof Lock Washers provide positive locking action that ordinary washers cannot give.



Only Shakeproof Lock Washers have these exclusive tapered-twisted teeth . . .

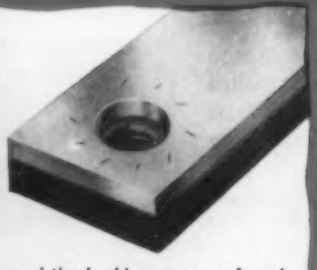


where each tooth is a strut to resist all loosening rotation of threaded fastening.

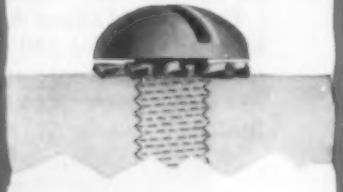


Spring tension forces the edges of each tooth to bite deeper.

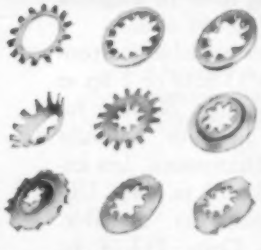
Shakeproof Lock Washers lock tighter as vibration increases . . .



and the locking power of each tooth is multiplied by the number of teeth.



Their exclusive mechanical lock resists loosening as no other lock washer can!



To meet the majority of your locking needs, there are nine standard types.

The variety and styles of "specials" to meet individual requirements are unlimited!

For maximum savings, buy Shakeproof Lock Washers pre-assembled on screws as SEMS.

Pre-assembled on nuts, Shakeproof Lock Washers save time—specify KEPS®.

Free Sample Kit

Now . . . make your own tests! See for yourself how SHAKEPROOF Lock Washers can save time in assembly and protect the quality of your products. Write for your free sample kit today!

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DIVISION OF ILLINOIS TOOL WORKS

St. Charles Rd., Elgin, Illinois • Offices in Principal Cities

In Canada: Canada Illinois Tools Limited, Toronto, Ontario

WORLD'S BROADEST LINE OF MASS-ASSEMBLY FASTENINGS

quirement is 250 milliwatt per pole. Dimensions, 1¼ x 3⅜ in. above mounting line. Hedin Tele-Technical Corp., 87 Dorsa Ave., Livingston, N. J.

For more information—
Circle 44, inside back cover

Magnetic Motor Control Relay

This relay carries full UL approval. The 9100 is a three-pole, single-throw, normally open relay. Motor load ratings are for 2 hp at 115 v, ac, and 3 hp at 230 v, ac, single-phase. For polyphase, the ratings are 3 hp at 115 v, ac, and 7½ at 230 v, ac. Coil voltage available in this model are for 12, 24, 115 and 230 v, 50/60 cps.

Contact load ratings are for 30 amp full load, and for 180 amp, stalled rotor, on both single and polyphase 230 v, ac. Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif.

For more information—
Circle 45, inside back cover

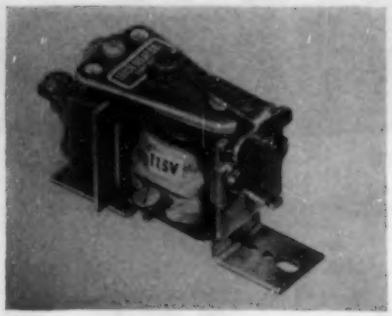
Metal Enclosed Appliance Relay

Completely enclosed in a metal case, this relay is plugged with molded bakelite on the contact end. Three contact leads are equipped with female AMP terminals; coil has two male AMP terminals. In either ac or dc the unit is available for 6 to 115 v. Contacts are rated up to 8 amp at 115 v non-inductive. Contact combination is single-pole, double-break. Dimensions are 2 11/32 x 1 7/32 x 1 7/32 in. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

For more information—
Circle 46, inside back cover

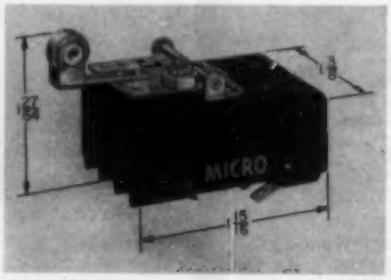
Magnetic Motor Control Relay

A single-pole, single-throw, normally open relay for motor control carries UL approval. This relay has motor load ratings of 1½ hp at 115 v, ac, and 3 hp at 230 v, ac. Contact load ratings are for 20 amp on either



115 or 230 v, ac, single-phase, and for 114 amp locked rotor at 230 v, ac. Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif.

For more information—
Circle 47, inside back cover



Single-Actuated Dual Switch

A single-actuated dual switch designed for a wide range of industrial control and electronic applications is of the low-force, double-pole design. It is said to have the ability to switch two isolated circuits at the same time. The switch consists of two basic switching units operated by a single roller-lever actuator. Operating point of one switching unit is field adjustable to provide either simultaneous actuation or a definite sequence of operation.

The 6AS13 is available with a variety of lever lengths, either straight or formed levers, with or without a roller. Positions of levers can be varied to left or right to fit existing applications in which a single-pole, double-throw basic switch was previously used. Basic switching units of the 6AS13 are UL–listed at 15 amp, 125, 250 or 460 v, ac; ½ amp, 125 v, dc; ¼ amp, 250 v, dc. However, various other basic switching units can be used to provide higher electrical capacity for d-c circuitry, or for special circuit applications. Dimensions: 1²³⁄₆₄ x 1¹³⁄₁₆ x 1⅜ in. Operating characteristics of the switch, assembled with two 15 amp basic switch units, are: operating force, 8 oz max; release force, ½ oz min; differential travel, 0.109 in., max; and overtravel, 0.020 in., min. Micro Switch, Freeport, Ill.

For more information—
Circle 48, inside back cover

All-Electronic Ultra-Sensitive Relay

Low-current, low-power devices or circuits such as an ordinary photocell are enough to activate this relay. The unit was specifically designed for control of high-power, high-current loads up to 60 amp or 3 hp at 115 v, ac, from devices or circuits with impedance values ranging from 10 megohm (3 microamp) to 100,000 ohm.

The relay is also available for control of loads up to 35 amp or 2 hp at 115 volts, ac, and may be had for either normally open or normally closed operation. Dimensions, less enclosure, are 2¼ x 5 x 8¾ in. long. UL-approved enclosures are available. Ebert Electronics Corp. 212-24 Jamaica Ave., Queens Village 28, N. Y.

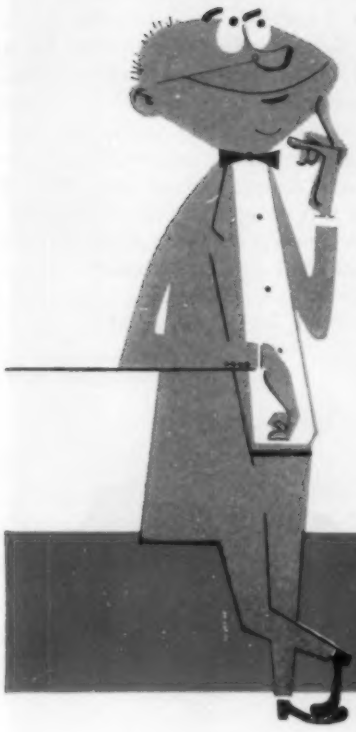
For more information—
Circel 49, inside back cover

Plunger Switch Handles To 20 Amp

Dozens of different switching combinations are said to be possible with a plunger switch that makes or breaks one or two circuits in sequence. It handles up to 20 amp at 230 v, ac. The plunger can be actuated by a cam, door or indexing knob. The compact design of the switch, 1⅜ in. dia, makes it practical to group several

CONTINUED ON PAGE 236

BEARING TROUBLES?



NO SIR! Not with new Reliance Motors and METERMATIC .... the

Automatic Grease Monkey

I found out how to put an end to burned out bearings from the Reliance Metermatic Bulletin, A-2406. Why don't you write for one? A-1490

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities

switches for synchronized operation by a rotary cam device. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

For more information—
Circle 50, inside back cover

Pressure Switches

This 4-oz pressure-sensitive device may be set to respond to hydraulic or pneumatic pressures of 100 to 12,500 psi. It is said to be applicable to industrial systems. Various mountings or envelopes are available. Gorn Electric Co., Inc., Stamford, Conn.

For more information—
Circle 51, inside back cover

Mercury Safety Switches

High current interrupting capacities, requiring a minimum of space, are said to be offered in a line of mercury contact switches for momentary pushbutton or selector type operation. Standard designs include fully enclosed models in single or multiple units, as well as open bracket types for panelboard applications.

Heavy duty, steel jacketed, mercury actuator contactors are hermetically sealed and provide safety for hazardous or corrosive atmosphere. Mercury-to-mercury contacts are friction free and possess a high order of efficiency both as to long life service and ability to absorb periodical high over-loads without damage to electrical characteristics. Industrial Automation Corp., 2415 W. Montrose Ave., Chicago.

For more information—
Circle 52, inside back cover

Miniature Pressure Switch

A series of miniaturized, vibration-resistant, differential and gage pressure switches originally developed for aircraft and missile systems applications operate in inert gases and fluids, engine and hydraulic oils and aromatic fuels, and are designed to withstand vibration up to 35 G. They weigh ⅓ lb. Operating temperatures range from −65 F to 165 F. Operating pressures of the Series 6300 range from 2 to 50 psi. Body length is 2 in. and the unit is 1½ in. dia. Southwestern Industries, 5880 Centinela Ave., Los Angeles 45, Calif.

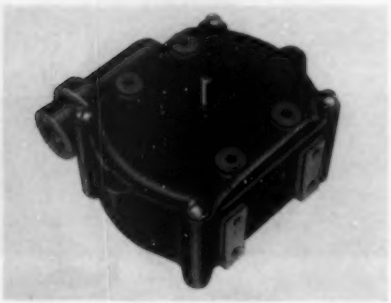
For more information—
Circle 53, inside back cover

Mercury Contact Pulse Switch

The rotation of this switch and the establishment of a temporary contact as the mercury flows past the electrodes is simplified by mounting the glass part within a cartridge. An instantaneous pulse of many amperes is caused to flow between the electrodes while the drop of mercury passes between them. Contact is made first and positively interrupted thereafter.

From the axes of the insulated cartridge protrude metallic contact rods concentrically on both sides. These external metal electrodes serve both as conductors of electricity as well as the means by which the switch is supported between uprights. They also make possible simple mechanical rotation of the cartridge. The pulse switch can be turned, tilted, driven by a motor or other means of rotation, whereby electrical contact is established for one pulse every 180 deg. Application of this new switch to pulsing and temporary contacting devices such as vending machines, electro-magnetic counters and other relay-operated devices flashing aircraft beacons, street lights and advertising signs is expected. Tensitron, Inc., Harvard, Mass.

For more information—
Circle 54, inside back cover



A-c Rotary Solenoid

Designed basically for a-c use, this solenoid can be operated by standard voltages without the use of rectifiers, transformers. The pure rotary movement produced at the shaft simplifies application by eliminating the need for counter-balancing the spiral action of some rotary devices. The torque developed by the solenoid provides all the desirable force characteristics of conventional linear-type solenoids, but permits installation without levers and linkages.

This rotary solenoid is essentially a toroidal coil system wound on a stator and a shaft-mounted rotor. When energized, the magnetic field causes the rotor and shaft to turn. Eight basic sizes provide a range of forms, offering a variety of torque values from fractional to 62.5 in.-lb at maximum stroke on continuous duty models. Intermittent duty models for higher torque values are available. Stock models give 20, 30 and 45 deg rotation. Any other rotation angles up to 60 deg

CONTINUED ON PAGE 238

4 ways to harness 'Jeep' POWER GIANT ruggedness

'Jeep' POWER GIANTS combine their tough ruggedness with real design simplicity . . . to add a new ease in field servicing to their unusually long operating life. Hitch up to this compact, powerful line of POWER GIANTS. Write for bulletins today!

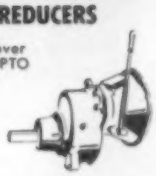
for tough, compact power . . . here's 70 horses in a 2 ft. length.

SAE BELL HOUSINGS AND CLUTCHES

Rugged cast SAE #4 and 5 bell housings support rear of engine. Clutch assemblies including splined disk and clutch for low cost coupling available.

SPEED REDUCERS

Incorporates over center clutch, PTO and reduction gears. Ratios from 1.37 to 3.9 to 1.



POWER TAKE-OFF

Direct drive with positive engaged and disengaged positions. Close adjustment of clutch without special tools.

AUTOMOTIVE TYPE TRANSMISSION

Installation includes automotive type bell-housing, clutch and transmission. An economical speed reducer, using production parts.

for special needs, please inquire

HITCH UP TO THESE LONG LIFE DESIGN FEATURES

Hours more of dependable service because of valve rotators and stellite valves.

Hard chrome piston rings maintain compression . . . longer!

Exclusive positive crankcase ventilation forces filtered air through engine carrying away all condensates.

Rugged strength only from drop forged crankshaft. Precision counter balancing for smooth balance.

Unusually strong copper-chrome alloy block that also increases piston ring life.

More power and less weight than any engine of comparable displacement.

SPECIFICATIONS

MODEL	Jeep	Hurricane	Lightning
Cylinders & Head	4L	4F	6L
Cu. In. Displ.	134.2	134.2	161.0
Range Max. BHP	22-60	22-70	28-75
Range Max. Speed	1200-4000	1200-4000	1200-4000

Write for: 4 & 6 cylinder bulletins
Power Unit Bulletin

WILLYS MOTORS, INC. *Industrial Engine Department*

1455 N. COVE BLVD. TOLEDO, OHIO

can be provided. Standard electrical rating is 115 v, 60 cps, ac. Lee Spring Co., Inc., Dept. 96, 30 Main St., Brooklyn, N. Y.

For more information—
Circle 55, inside back cover

Pressure Control Switch

Available in both single and double terminal models, this gage, encased in a stamped steel, hermetically sealed case, has close on-and-off settings and is said to consistently hold precise cut-in, cut-out settings in test installations. A spring-loaded diaphragm, in a special seat design, can be equipped with optional additional overload protection in the form of a special stem-located dampener mechanism. The new gage measures 1¾ x 2⅞ in. from top of terminal to end of fitting. Available also with ¼ or ⅛ in. threaded fitting. Pressure range is to 100 lb. Rochester Mfg. Co., Rockwood St., Rochester 10, N. Y.

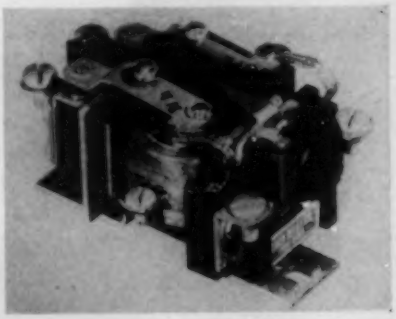
For more information—
Circle 56, inside back cover

Watertight Switches

These switches are designed to withstand water, dust and oil. An O-ring shaft seal, captive cover screws, a watertight switch cover, and six back cover screws are used. In addition a glass fibre arc shield has been adopted.

The new switches are made in a variety of styles which include: double-pole, single-throw, double-break; three-pole; double-break; double-pole, single-throw, double-break; neutral-position, double-throw, double-break, normally open; neutral-position, double-throw, double-break, normally-closed. All models have isolated circuits. R. B. Denison Mfg. Co., 102 St. Clair Avenue N. W., Cleveland 13, Ohio.

For more information—
Circle 57, inside back cover



Two-Pole Magnetic Motor Controller

Small size, quiet operation, low coil power, and screw terminal connections for simple installation are said to be provided by a two-pole, single-throw relay for motor starting and industrial control of refrigeration and heating equipment. This relay has full UL approval. Designed for normally open operation, motor load ratings are 1½ hp at 115 v, ac, and 3 hp at 230 v, ac. Maximum contact load ratings are for 20 amp at either 115 or 230 v, ac, single-phase, and 114 amp locked rotor at 230 v, ac. Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif.

For more information—
Circle 58, inside back cover

Adjustable Speed Drive

This unit can be coupled or belted to an existing motor to provide a speed control of ±2 per cent for fans, centrifugal pumps and compressors, and is also designed to handle constant torque loads such as mills, conveyors, machine tools. With it, the user can operate a load at the optimum speed; can change speed smoothly by means of a knob, or can control it automatically: The system consists of a drive installed between the motor (or other drive) and the load, a wall-mounted magnetic amplifier speed control and a control rheostat mounted at any convenient location. The drive is air-cooled and requires no external cooling system. It can be either belted or coupled to the motor and load.

The drive itself consists of a "ring member" connected to the input shaft and driven by the motor, and a "magnet member" which is mounted on the output shaft and turns the load. There is no solid physical connection between the ring and magnet member, although they are connected through two bearings. The ring member is driven at constant speed. The magnet member is excited by d-c current from the control, and the d-c current through the field winding sets up a magnetic attraction between the two rotating members. More field excitation increases the magnetic force between the constant speed ring member and the magnet member, so that the magnet member speed increases.

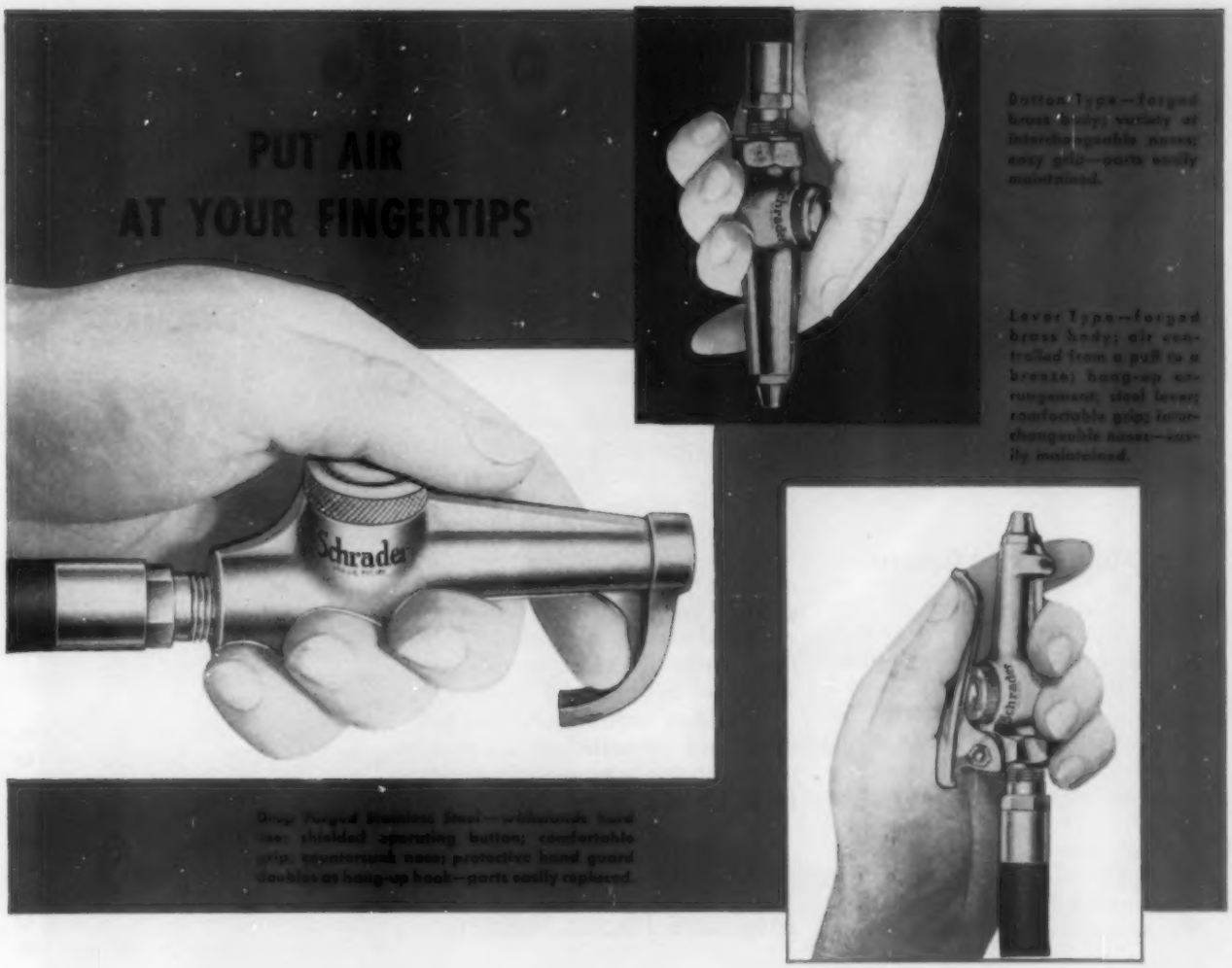
The new drive is designed for use with motor speeds of 870, 1150, or 1750 rpm. Horsepower ratings of the two sizes range up to 95 hp for fan-type loads. For constant torque loads, the output ranges up to 75 hp, depending upon input speed and required speed range. Electric Machinery Mfg. Co., Minneapolis, Minn.

For More information—
Circe 59, inside back cover

Small Two-Circuit Limit Switch

This switch is equipped with a roller-arm actuator which can be field-adjusted through 360 deg with positive locking in any position. Actuation can

CONTINUED ON PAGE 240



Use Schrader blow guns . . . 36 designs and styles

Schrader Blow Guns are made to *fit your hand . . . fit your job!* Schrader Blow Guns are built to take it—here's why:

They're rugged both in design and construction. Bodies are drop-forged either of brass or stainless steel.

They're convenient—can be used anywhere. Blow gun circuits—using Schrader Couplers, Hose and Automatic Hose Reels—take little space, yet put compressed air right at your fingertips.

They're economical—they have few moving parts. And replacement parts, when and if needed, are easily installed.

They're versatile—with nine interchangeable noses—both fixed and adjustable—that fit all three standard-type guns, you can't think of a blow-gun application that Schrader can't meet.

It's easy to find out for yourself what a wide selection of blow guns is in the complete Schrader Line of air control equipment. Write today—or, if you prefer, fill out the coupon below.

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LEADERS IN AIR CONTROL SINCE 1844

SPECIAL ADJUSTABLE NOSES

VARIOUS STANDARD NOSES

The complete Schrader line of pneumatic accessories includes everything you need

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477 Vanderbilt Avenue, Brooklyn 38, N. Y., Dept. C-10

I am interested in more information on _____

Name _____ Title _____

Company _____

Address _____

be clockwise, counter-clockwise or in both directions. The actuator head may be removed in the field and faced at any of four positions at 90 deg angles.

Contact arrangement is two-circuit, double-break. Electrical rating is 10 amp at 120, 240 or 480 v, ac; pilot duty rating is 0.2 amp at 115 v, dc, 0.1 amp at 230 v, d-c, and 0.04 amp at 550 v, dc. Micro Switch, Freeport, Ill.

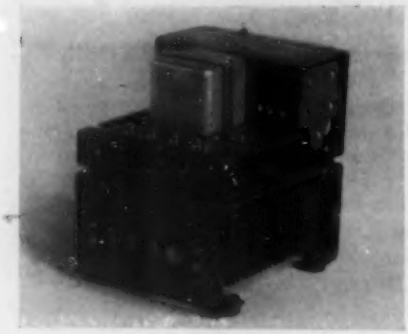
For more information—
Circle 60, inside back cover

Fhp Motor Speed Control

This reactor-type control, for varying or reducing voltage on 1/50 to ⅛ hp shaded pole motors, has capacities of 0.5 to 7.0 amp, 20 to 40 v drop, 115 and 220 v line voltage. Adjustment mechanism is of the sliding type.

Dimensions are 3 x 4 x 6 in. This control may be used to reduce speed on shaded pole and split capacitor motors and to reduce voltage in other a-c equipment. Killeen & Son Production Engineering Co., 340 W. Compton Blvd., Gardena, Calif.

For more information—
Circle 61, inside back cover



Motor Speed Control

Illustrated is a 1/15 hp control. Other larger units will be available. They are designed to deliver stepless control from dead stop to above base speed. Motor speed is set by the operator and thereafter remains constant within 2 percent in spite of line and load variations. All the standard features such as dynamic breaking, reversing are available. No electronic tubes are used in these controls. Electric Regulator Corp., Pearl St., Norwalk, Conn.

For more information—
Circle 62, inside back cover

Speed Control for 1 Hp Applications

This 1 hp variable speed unit occupies maximum space of 16⅞ x 21½ x 11½ in. in vertical model. Available in speed ranges of 2:1 through 8:1, the controller can be obtained in any one of 112 different assemblies to meet space requirements. A new spiral groove lubrication system is used. In case of excessive lubrication, "overflow" outlet carries excess lubricant away from disc faces and V-belt.

Handwheel control is standard but mechanical, automatic and electric remote controls also are available. Reeves Pulley Co., Columbus, Ind.

For more information—
Circle 63, inside back cover

Miniature Electro-Magnetic Clutch

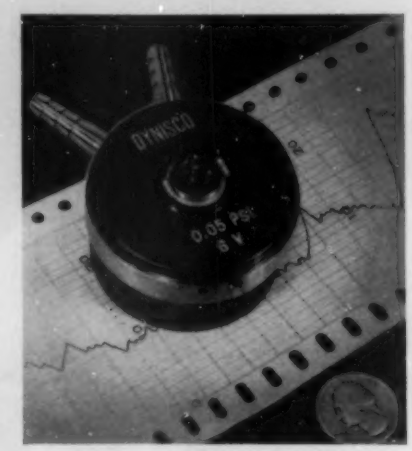
This clutch is 1⅞ x 2⅜ in. long, weighs 5½ oz, has a torque output of 7 in.-lb and a power consumption of 3 w. The clutch has a speed of response in the neighborhood of 10 to 15 millisec.

In addition to on-off clutch service, the unit may be used as a high speed non-chattering brake, and for slip applications for restricted periods of time. The design of the clutch allows for considerable mis-alignment between the driving and driven members without malfunction of the unit. Dial Products Co., 7 Bergen Court, Bayonne, N. J.

For more information—
Circle 64, inside back cover

Low-Range Pressure Transducers

This unit measures either gage or differential pressure in the ranges 0.00 to 0.05 and 0.00 to 1.00 psi. High accuracy and high resolution characteristics are reported to make the new pickup particularly suitable for sensitive air-flow measurements, vacuum equipment studies, precision altimeters and medical research equipment.



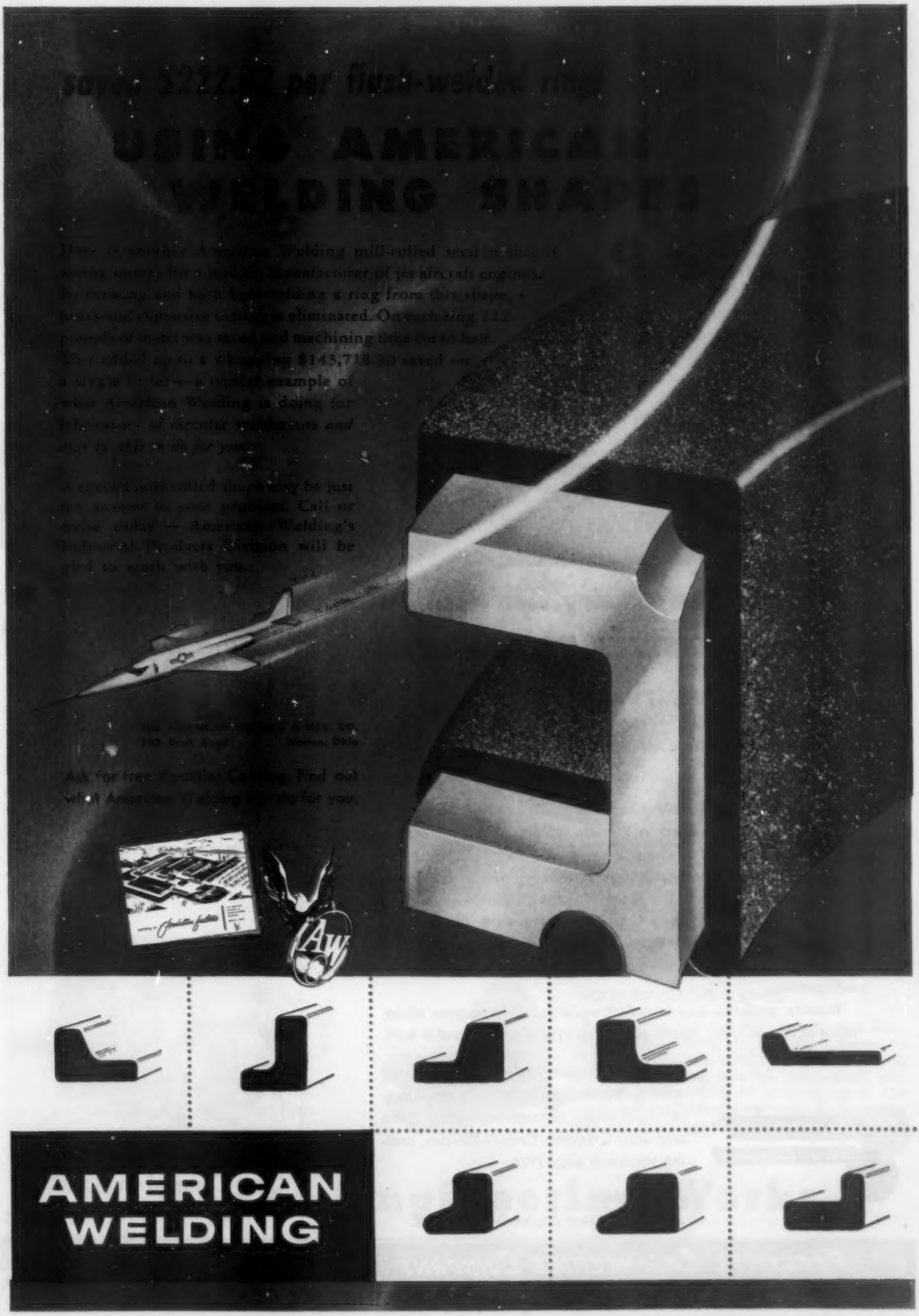
The pickup consists of a 1⅞ in. dia, beryllium-copper bellows fastened to the rigid pickup case and connected to a special, strain-sensitive resistance bridge. Separate input pressures are brought to bear on either side of the bellows through threaded connection holes in the pickup case. Movement of the bellows produces an electrical output signal proportional to the difference between the two pressures. The design can withstand overloads up to 15 psi. The pickup is housed in a case 2¼ x 1⅞ in. high. Dynamic Instrument Co., Inc., 28 Carleton St., Cambridge, Mass.

For more information—
Circle 65, inside back cover

Motor Reduces Starting Shock

For two-step starting, half of this motor's winding is energized across the line as the first magnetic contactor closes. At the end of a timed cycle, the second contactor closes to bring in the second half of the winding in parallel with the first. In typical three-step starting, the motor starts with reduced voltage on the first winding, accelerates as full voltage is added to the first winding and then, in the third step, reaches rated speed as the second winding is brought in at full voltage. Even less current draw than

CONTINUED ON PAGE 242


saves $222.[illegible] per flash-welded ring
USING AMERICAN
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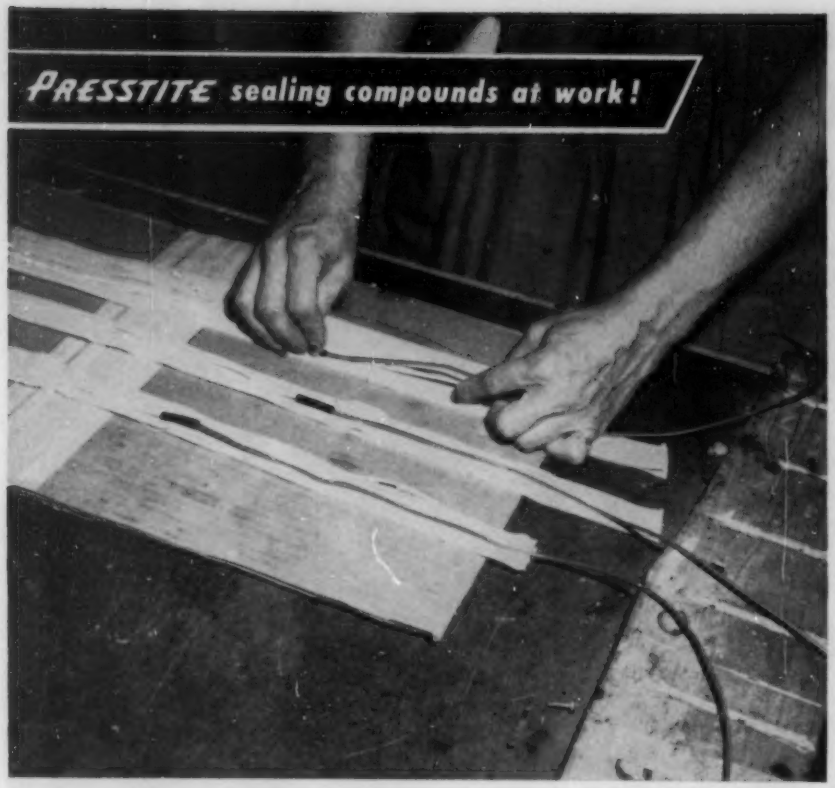
AMERICAN
WELDING



keep it hot, keep it dry...in a cold place with PRESSTITE PERMAGUM® sealing ribbon #576.1

Problem: To hold the refrigerator mullion heater wire assembly securely in place.

Solution: Before installing heater wire units behind the mullion, wires are firmly imbedded in Presstite #576.1 Permagum sealing ribbon. This insulates the wire and keeps heat from going back into the insulation area. Permagum's high adhesive bond holds the heating assembly firmly in place. The sealer features excellent resistance to water and moisture; it never hardens or becomes brittle, even at temperatures as low as -40°F. and never slumps at temperatures up to 350°F. It has no contaminating odor, especially important in refrigeration.

Presstite produces over forty (40) varieties of Permagums alone; tapes as thin as 1/16", beads as small as 1/8" diameter, and in bulk.

Over 400 Presstite sealers provide for any sealing requirements in aircraft, appliance, communication, automotive, refrigeration and other industries. Consult Presstite, sealing specialists since 1924.

PRESSTITE SEALING COMPOUNDS

In Canada:
Railway & Power Engineering Corp., Ltd.

PRESSTITE ENGINEERING COMPANY

3750 CHOUTEAU AVE. • ST. LOUIS 10, MO.

is needed with these standard steps can be provided. These motors are available for normal and high torque applications, in all standard enclosures. Power ratings are 5 to 200 hp. Howell Electric Motors Co., Howell, Mich.

For more information—
Circle 66, inside back cover

Pressure Transmitter

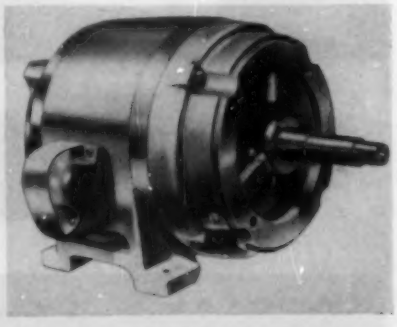
This instrument is presently available in pressure ranges up to 0 to 20 psi, absolute, differential or gage. Repeatability is within the limits set by the resolution of potentiometer winding of 230 wires (0.45 per cent). Dimensions: 2.4 x 1.75 in. dia. Weight is less than 6 oz. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

For more information—
Circle 67, inside back cover

Fan-Cooled Motors 1 to 5 Hp

This totally enclosed, fan-cooled motor is recommended for use in dirty, dusty, fume and mist-laden atmospheres that could damage the ordinary open motor. In addition to meeting all NEMA requirements, the new drive's fan is designed to provide operation in either direction. Brackets are provided for bolting the motor to the machine or the machine to the motor. Century Electric Co., 1806 Pine St., St. Louis, Mo.

For more information—
Circle 68, inside back cover



Close-Coupled Pump Motor

A motor with a face-type registered bracket and special shaft suitable for close-coupled centrifugal pump applications has been developed. Built to the rerated NEMA specifications, the

for

Exacting

CYLINDER CONTROL

¼" UNITITE JR. VALVES

Hanna ¼" Valves control air, oil or water pressures up to 500 p.s.i. The control lever requires only 80° movement for reversal. Hanna ¼" Valves are 4-way but can be made 3-way, by plugging one port. Three models — column, standard and manifold mount—are available. Ideal for tubing and light piping.

ELECTRIC VALVES

The Hanna 4-way Solenoid Valve is small, compact, with low current consumption. It is adaptable to straight line piping—capacity is equal to rated pipe size. Of balanced spool type, it has a built-in solenoid pilot valve. Piping may be from bottom, sides or a combination. Available in ⅜", ½", ¾" and 1" pipe sizes.

Hanna® valves

CHOOSE FROM a broad selection of Hanna Valves to meet your requirements for exacting Air and Hydraulic control. Illustrated are but a few of the complete line of hand, foot, electric and pilot operated valves for directional and speed control. They all carry the Hanna nameplate—an assurance of extraordinary care in design and manufacture—which means years of maintenance-free operation. Your Hanna sales representative offers specialized experience in selecting valve combinations and developing control circuits.

SEND FOR CATALOG

Hanna Valve Catalog No. 254 includes descriptions and specifications on the complete line.

SPEED CONTROL VALVES

Hanna Flo-Set Valves have micrometer graduations to assure exacting speed control. Available in ¼", ⅜", ½" and ¾" sizes, they are suitable for air, oil or water control, with maximum pressure to 250 p.s.i. They may be mounted in any position.

UNITITE VALVES

Unitite Valves are suitable as either 3-way or 4-way valves, operating at air, oil or water pressures up to 250 p.s.i. for the ⅜", ½", and ¾" sizes . . . up to 150 p.s.i. for the 1" size . . . and up to 100 p.s.i. for the 1¼" size. Three styles—for standard mounting, column mounting or manifold mounting—are available.

FOOT OPERATED VALVES

Available in ⅜", ½", ¾" and 1" pipe sizes, Hanna Foot Valves are ideal for applications where it is desirable to have the operator's hands free for handling material. Single-pedal and double-pedal models, for pressures up to 250 p.s.i., are available for use with double-acting air and hydraulic cylinders.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

1763 Elston Avenue, Chicago 22, Illinois

The *New Peerless® Electric*
BACKWARD CURVE BLOWER CATALOG

A CONCISE GUIDE TO BETTER BLOWER APPLICATIONS

This fact-packed 36-page catalog tells you everything you need to know about backward curve blowers. It shows the complete range of sizes from 12½" to 36½"; lists all performance ratings for each size at each motor rating; shows all variable speed ranges; gives you finger-tip reference to CFM ratings, outlet velocities, discharges and rotations. All blower performance ratings are guaranteed by Peerless. These facts are your guide to better, more efficient and more economical blower applications. If you require any special design features or engineering aid to develop the proper blower for your equipment, Peerless engineers will work with you to make it possible. Call us today. There's no obligation.

FAN AND BLOWER DIVISION
THE PEERLESS ELECTRIC COMPANY
FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT
1406 W. MARKET ST. · WARREN, OHIO

Smoothest Performers
Peerless® Electric
on the Market

motor is available in ratings from 1 to 30 hp.

For additional protection against water entering the motor, deflectors direct air and deflect water. The castings are normalized for permanent accuracy. Windings are asbestos-protected. Split-type conduit box can be rotated in 90 deg steps and located on either side of the motor. Rotors are electronically balanced and solid cast. U.S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

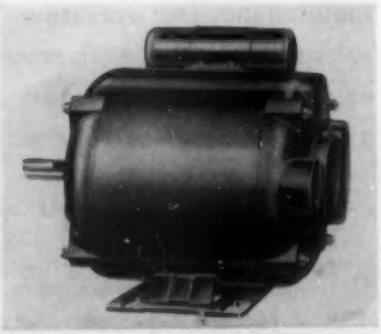
For more information—
Circle 69, inside back cover

Totally Enclosed Air-Over Motor

A totally-enclosed air-over motor, said to be nearly 30 per cent lighter than previous models and approximately 20 per cent smaller, is designed to produce varying horsepower with the application of varying air velocities. The new non-ventilated motor is particularly suited to air-moving applications. The motor is cooled by the air flow over it caused by the fan or blower it powers. Horsepower output can thus be increased without exceeding the rated temperature rise of the motor.

The new motor is available in ½ through 5 hp ratings and in frame sizes 182, 184, 213 and 215. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 70, inside back cover



Fhp, Dual Voltage Motors

A line of single-phase motors with ball bearings and dual-voltage windings at a price said to be approximately that of sleeve-bearing, single-voltage motors has been introduced. Used for driving air conditioning and

WE GAVE THEM THE THREE T'S

TIME TORQUE AND TEMPERATURE

The Power

Peerless® Electric

that Builds Reputations

Here's how Peerless works with OEM's to produce the motors they need.

This rugged Peerless Motor is a standard Peerless model adapted to the special requirements of a dry cleaning equipment manufacturer. It accelerates a 300-350 pound load of cleaning from rest to 30 RPM smoothly. It reverses under the same load during the washing process, and it does it all within safe temperature limits. The constant change of work load weights is handled easily and efficiently.

Peerless Electric engineers worked with the OEM engineers to design this motor for a specific application. It is one of hundreds of teamwork engineering tasks performed by Peerless.

Let's put our heads together and solve your motor problem. Call or write Peerless today. We'll help you design or select the Peerless Electric motor that operates your equipment best.

ELECTRIC MOTOR DIVISION

THE PEERLESS ELECTRIC COMPANY

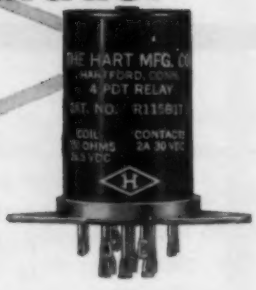
FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

1509 WEST MARKET STREET • WARREN, OHIO

Photo courtesy the Martin Company

Relays for the Matador

by "DIAMOND H"



Matadors, surface-to-surface tactical missiles now deployed with USAF operational squadrons in Germany, are products of the Martin Company, Baltimore.

The relays, developed to help control its near speed-of-sound flight, are products of The Hart Manufacturing Company.

They're 4 PDT hermetically-sealed relays with a previously unobtainable combination of dependable characteristics engineered into remarkably small space and weight.

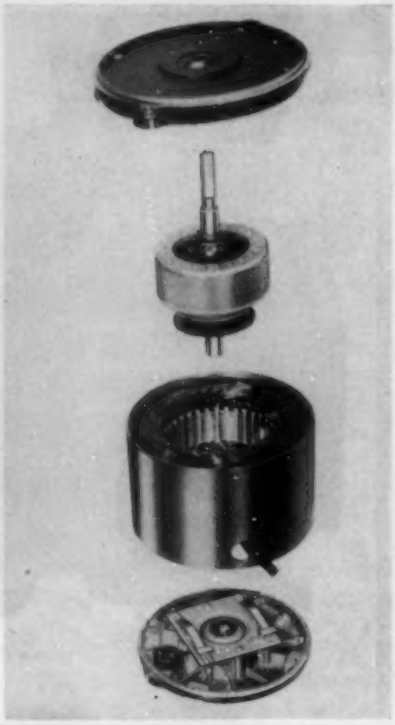
A new bulletin gives complete data on the wide range of performance characteristics which can be obtained with "Diamond H" Series R relays for critical jobs in the *Matador* and other missiles, jet aircraft controls, computers, high-speed cameras and other vital applications. Write for a copy today.

The Hart Manufacturing Company

206 Bartholomew Ave., Hartford 1, Conn.

refrigeration machines, fans, pumps and blowers, compressors, conveyors, oil burners, the motors are offered in ¼, ½ and ¾ hp, and 1200, 1800 and 3600 rpm ratings, for 115 or 230 v, 60 cps. Acec Electric Corp., 40 E. 49 St., New York 17, N. Y.

For more information—
Circle 71, inside back cover



Electric Motors of 1/6 to 1/12 HP

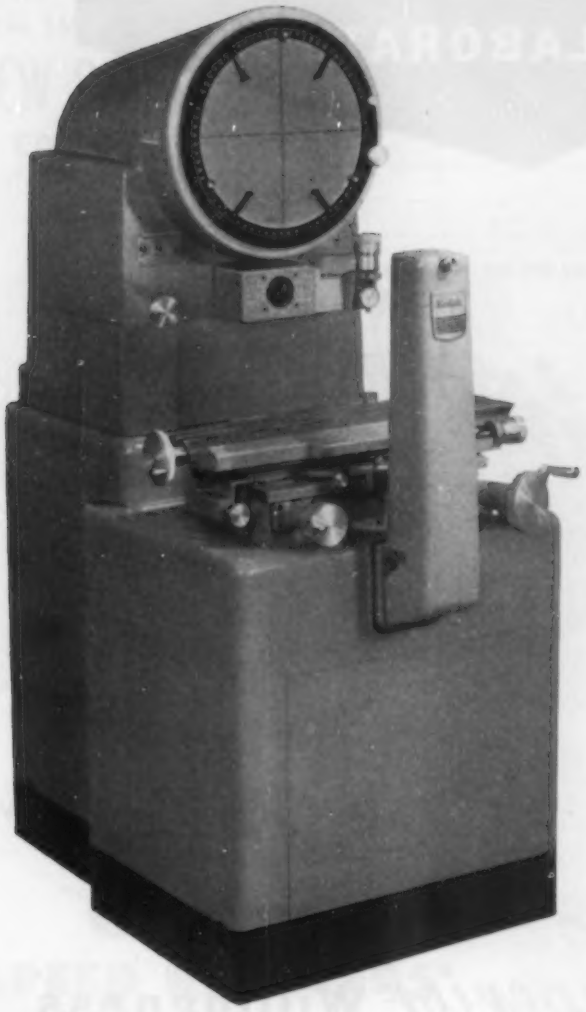
UL-approved and built to NEMA specifications for oil burner motors with No. 56 frame, these motors are available in ⅙, ⅛, 1/10 and 1/12 hp sizes, either for 115 or 230 v, 50 cps (1450 rpm) or 60 cps (1725 rpm) operation. Weight is 15½ lb, average. The Ohio Electric Mfg. Co., 5400 Dunham Road, Maple Heights, Cleveland, Ohio.

For more information—
Circle 72, inside back cover

Permanent-Magnet Motor

These d-c motors have permanent magnet field assemblies and are 1½ in. long. Weight is less than 3 oz. Housing is machined from solid aluminum and low-torque ball bearings are supplied.

Various electrical characteristics are



Here's how
Kodak combines
added work capacity with 14-inch screen economy
in the **new Kodak Contour Projector** Model 14-5

If you make heavy, bulky parts to close tolerances, the new Kodak Contour Projector, Model 14-5, has a place in your inspection program.

For the 14-5 combines the heavy-duty work table and 8″ travel of the Model 30 with the economy of a 14-inch screen.

The result: a projector that makes light work of checking heavy parts.

Mechanically, the Model 14-5 provides a large (26″ x 8″) work table built to handle heavy loads without measurable deviation. A full 17.5″ throat clearance helps you position cumbersome parts quickly and easily. Table travel of 8″ in both horizontal and vertical planes speeds measurement. A built-in helix table rotates 15° in either direction for gaging threads or similar parts.

Optically, the Model 14-5 incorporates all the unique developments that have made the Kodak Contour Projector, Model 2A, leader in its field: bright screen image for easy reading, six-station lens turret for instant change of magnification, and self-contained Surface Illuminator.

For complete information on the Model 14-5, write for the new 12-page booklet "Projection Gaging with Kodak Contour Projectors." It tells how this new precision projector can help you check parts and components to accuracies of the order of .0001″—quickly and economically.

EASTMAN KODAK COMPANY
Special Products Sales Division, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
TRADE-MARK

TO ELABORATE....

This brush assembly conducts signal and power current through slip rings between stationary and rotating equipment.

a *Superior* Willingness to ELABORATE

"Elaborate"? Yes, that's exactly what we mean. For, actually, "elaborate" means to *work* something *out.* Always, we at Superior are most willing to *work out* exactly what your application calls for . . . the right answer to perform a brand new operation most efficiently, to make your present equipment function more profitably, or to bring down the cost of manufacturing your product. *Please turn us loose on that next brush assembly problem.*

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE CLEVELAND 5, OHIO

SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

available with a range of operating voltages from 6 to 80 v, no-load speeds of 3000 to 20,000 rpm, and power output up to 11 w, or approximately 1/70 hp. Servo-Tek Products Co., Inc. 1086 Goffle Road, Hawthorne, N. J.

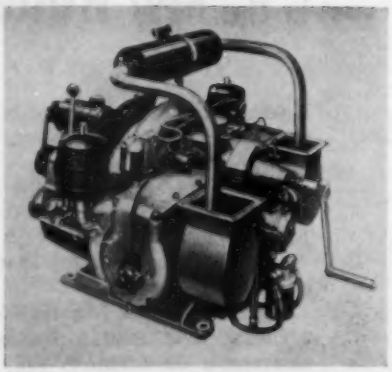
For more information—
Circle 73, inside back cover

Subfractional Motor 3-in. Dia.

These synchronous motors have stainless steel shafts. The class is basically of the reluctance type, but the rotor is completely cylindrical with no irregularities or slot openings. This is said to promote more uniform torque and quieter operation.

The stator has slotted construction with distributed windings. Mylar insulation is used in the stator slots. End caps are of die-cast aluminum. Either ball or sleeve bearings are available. The standard mechanical construction provides face mounting by means of the motor's own frame screws. Available ratings include motors of 1/50 to 1/200 hp, 1700 to 36 rpm. Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., 125 Armory St., Boston, Mass.

For more information—
Circle 74, inside back cover



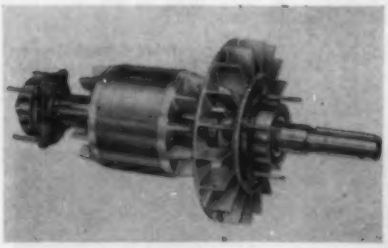
Air-Cooled Diesel Engines

A line of small diesel engines, manufactured in England, include two single cylinder engines of 568 and 785 cc displacement, and two flat twin-cylinder engines of 1135 and 1570 cc displacement. All engines can be supplied as marine, stationary or portable models.

Cooling is accomplished by means of a fan which is integrally cast on the

flywheel. The air is drawn in and discharged at high velocity over cowled cylinders and cylinder heads. It is asserted these engines can be operated satisfactorily at temperatures up to 130 F. Dept. EE, British Marine Products, Ltd., Port Washington, N. Y.

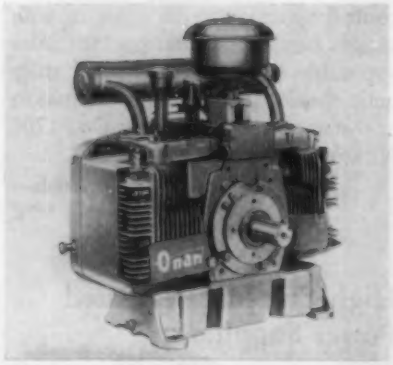
For more information—
Circle 75, inside back cover



Additional Fan Makes Motor Run Cooler

These drip-proof motors have a turbine-type fan for further reduction of motor operating temperatures. Mounted on the motor shaft, the fan is a one-piece aluminum die-casting. Because of the motor's added fan capacity and aerodynamic air passages, more than four times the usual quantity of cooling air is said to be circulated between frame and stator and through the full length of the motor. Acec Electric Corp., 40 E. 49 St., New York 17, N. Y.

For more information—
Circle 76, inside back cover



Air-Cooled 13 Hp Engine

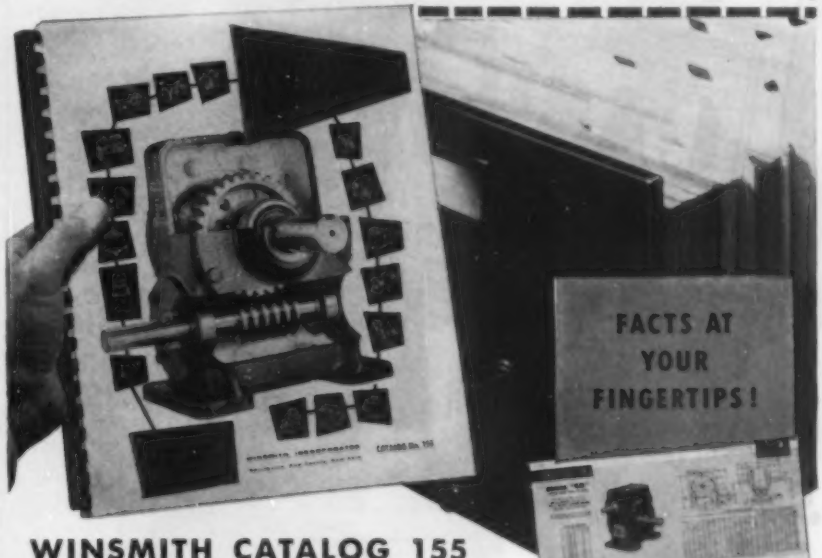
Typical applications for this two-cylinder commercial engine include railway maintenance equipment, refrigeration units, irrigation and contractors' pumps, air-compressors.

The CCK engine is a horizontally-

AN IMPORTANT
NEW CATALOG
FOR YOUR
FILES!

WINSMITH, Inc., 111 Eaton Street
Springville, (Erie County), N. Y.
Gentlemen: Please send me a copy of Catalog 155 on the new Series "C" Speed Reducers.

NAME TITLE
COMPANY
ADDRESS
CITY ZONE STATE



WINSMITH CATALOG 155
DESCRIBING THE NEW
"C" SERIES
SPEED REDUCERS

Between the covers of this new catalog, every design engineer and speed reducer user will find the answer to how they can select speed reducers of more compact dimensions to achieve required output.

With this newly designed "C" Series, Winsmith has succeeded in increasing horsepower and torque output, and increasing the ruggedness of the units *without increasing overall size*. In all, 108 models in single and double reduction are available within the range of .01 to 34 hp; in a ratio range of 5:1 to 4460:1 and in an output torque range of 142 in. lbs. to 34,767 in. lbs. The complete "C" Series plus a number of other popular models in the Winsmith line are catalogued for your working convenience.

FOR YOUR COPY OF
CATALOG 155 FILL IN AND
MAIL THE COUPON
TODAY!

WINSMITH
SPEED REDUCERS

...a single source for the most complete line of speed reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1

WINSMITH, INC.
111 Eaton Street
Springville, (Erie County), N. Y.

NEW BACK PRESSURE RELIEF VALVE...

SHUTS OFF TIGHT

WITH PRACTICALLY NO PRESSURE DROP BELOW RELIEF SETTING

CHATTER FREE

For Pressures From 0 to 400 Pounds P.S.I.

Extra Large Capacity • Unusually Sensitive

- Available in iron, bronze, monel or stainless body. Size ½ to 2" inclusive, with bronze, monel or Neoprene diaphragm.
- Suitable for use on practically all fluids and gases. Especially suited for oils of all grades, including Bunker "C".
- For additional information on Type FR, and other new automatic valves in the Cash-Acme line, write our Engineering Department at the address below. To avoid delay, please include a brief outline of your pressure conditions and requirements.

Cash-Acme's Type FR back pressure relief valve automatically maintains correct pressure on the inlet side, by relieving into a lower pressure line. It is not affected by pressure variations on the discharge side. Provides protection against periodic high pressure conditions. Can be used with modification as a differential pressure regulator—holding a constant difference in pressures between valve inlet and valve outlet. Valve action is fully floating for smooth and even control. New patented "Floating ring" is unusually sensitive—gives exceptionally good closure. Large capacity in almost frictionless performance.

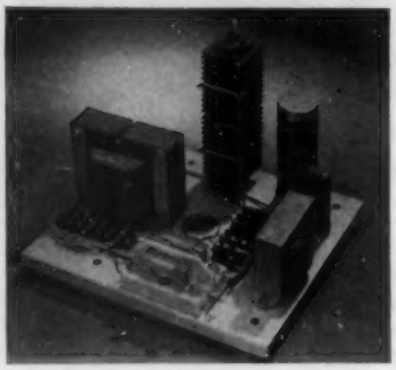
CASH ACME — A. W. CASH VALVE MANUFACTURING CORP.

6662 E. Wabash Avenue Decatur, Illinois

The Complete Cash-Acme Line Includes Pressure Reducing and Regulating Valves, Relief Valves, Back Pressure Valves, Vacuum Regulators and Vacuum Breakers, Differential Pressure Regulators, Strainers, Diaphragm Control Valves.

opposed, four-cycle, air-cooled engine rated at 12.9 hp (corrected bhp with accessories) at 2700 rpm. It is gasoline driven, has a 3¼ in. bore, 3 in. stroke, 50.0 cu in. piston displacement and the compression ratio is 5.5:1. It weighs 148 lb, dry, with standard accessories. Piston speed is 1350 fpm at 2700 rpm. Dimensions are 19½ x 17⅞ x 14¾ in. long. It is manually started by means of a pull rope, although a starter is optional. D. W. Onan & Sons, Inc., Minneapolis, Minn.

For more information— Circle 77, inside back cover



D-c Power Supply

Municipal fire alarm systems use this selenium bridge rectifier as a continuous source of d-c power for fire alarm boxes throughout a community. The unit is low internal impedance, choke-condenser hum filtering, and is said to require no warm-up.

Power sources up to 500 v, dc, and 500 milliamp for all types of signal or control systems can be built in with various mechanical arrangements. Also applicable to the excitation of magnetic chucks, small motors, alternators or dynamometers. Slaughter Co., 1700 Nicklin Ave., Piqua 4, Ohio.

For more information— Circle 78, inside back cover

High-Current, Regulated Power Supplies

These supplies are said to exhibit zero recovery time from a line or load transient. They have been successfully used in computers, telemetering systems and aircraft-control applications in which the power supply must simulate an "ideal battery".

Standard regulation is 0.5 per cent

the "inside" story!

SILICON STEEL LAMINATIONS—give high efficiency.
HARDENED BERYLLIUM COPPER PLUNGER GUIDE — reduces friction and wear.
SHOCK - ABSORBING BUMPERS — reduce self - destruction, cushion stroke, assure longer service.
HEAVY SILICONE INSULATED MAGNET WIRE — wound on high flow point molded nylon bobbin.
TEMPERED STEEL SPRING — absorbs vibration — holds assembly firmly in alignment.

of dependable

Decco

INDUSTRIAL SOLENOIDS

HORIZONTAL PUSH-TYPE WELDED BASE

VERTICAL PULL TYPE SHOCK-MOUNTED

VERTICAL PUSH-TYPE WELDED BASE

AC WAFER SOLENOID

DC INDUSTRIAL SOLENOID

FOR COMPLETE INFORMATION ON ALL DECCO INDUSTRIAL SOLENOIDS WRITE:

In addition to all the "inside" advantages, Decco Solenoids are compactly designed and thoroughly impregnated with silicone baking varnish for high moisture resistance.

Decco Solenoids are made in all types, sizes and shapes. SPECIAL SOLENOIDS ENGINEERED TO YOUR PROBLEMS.

Decco SOLENOIDS THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

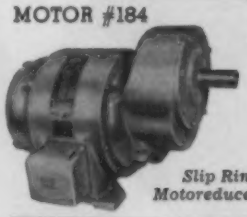
SAVE

on original development costs
by using REULAND ELECTRIC'S

SPECIAL-MOTOR "LIBRARY"

Over 900 Different
Electric Motors

MOTOR #184



Slip Ring Motoreducer

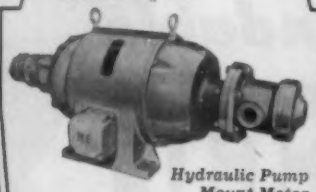
HIGH STARTING TORQUE ON LOW CURRENT—plus variable speed reduction, are features of this Slip Ring Gear Reducer motor. Aids in getting heavy loads up to full speed through step by step starting.

MOTOR #107

Fluid-Shaft Motoreducer with Brake

FLUID-CUSHIONED ACCELERATION, SLOW SPEED, SPLIT-SECOND BRAKING—Internal fluid coupling provides smooth starts, prevents "jamming" of equipment. New "doughnut" magnetic brake can be mounted before or after coupling—or both.

MOTOR #841



Hydraulic Pump Mount Motor

MOUNT PUMP DIRECTLY TO MOTOR'S END BELL—Eliminates usual need for separate pump-mount platform. Insures absolutely perfect alignment with pump shaft. Available with flange on one or both ends. For all standard pump makes.

MOTOR #912

Right-Angle Worm Motoreducer

COMPACT SPEED REDUCER—This right-angle, worm type gear reducer provides lowest cost speed reduction. Mounts on floor, overhead or side. Extremely versatile, multi-shaft load hook-up. Fits tightest quarters.

REULAND'S "XPANDABLE" DESIGN MEANS ALMOST UNLIMITED ADAPTABILITY . . .

Don't pay for special motor development until you first check the Reuland SPECIAL-MOTOR LIBRARY. Reuland's revolutionary new XPANDABLE DESIGN idea has produced literally hundreds of unique power packages, one of which may already be the answer to your needs.

Reuland also produces a complete line of standard electric motors. Free engineering literature will be sent upon request. Your inquiry will be given prompt, personal attention.

RE **REULAND ELECTRIC COMPANY** *Distributors In All Principal Cities*

Western Division: Alhambra 7, Calif. — Eastern Division: Howell 7, Mich.

against static line changes of 20 per cent, static load changes of 100 per cent, dynamic line changes of 10 per cent and dynamic load changes of 25 per cent. Standard ripple is less than 0.1 per cent. There is no practical liimt to size, although the system is most economical in the region from 4 to 160 v, and 4 to 100 amp. NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.

For more information—
Circle 79, inside back cover

High Speed Rotary Switch

A 12,000 rpm, 115 v, 400 cps, single-phase motor drives this switch's brush assembly at 10 rps with 7 w of power. Three sets of carbon-type brushes bear on precious metal segments.

Phasing is factory aligned to less than 0.2 ms. The case is hermetically sealed and provided with radiating fins for motor cooling. Switch can carry 0.1 mv to 100 v from 3 microamp to 50 ma current. Life is in excess of 500 hr, meeting MIL-STD-202 specification requirements. Size is 2½ x 5½ in. long. This switch weighs 2½ lb. Instrument Development Laboratories, Inc., 163 Highland Ave., Needham Heights 94, Mass.

For more information—
Circle 80, inside back cover

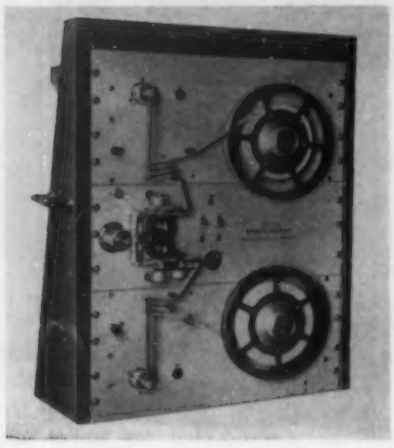
Reports Shaft Positions

Essentially an induction device, this shaft position device has no gears or digitizing commutators. Designed as a standard package, it is adaptable to any shaft. The four standard models, functioning with the standard control unit, divide one turn of a data shaft into any one of many possible divisions, which range from 320 to 4096 parts. The total count is accurate to plus or minus one count for any position of the shaft and is guaranteed whether the data shaft is stationary or turning at up to 240 rpm.

An external command pulse initiates a shaft position reading. The output count is an exact measure of the shaft position at the instant of the command pulse. That is, there is absolutely no dynamic lag. Manual or automatic command pulses may occur at regular or irregular intervals up to

20 readings per second. Shaft velocity and acceleration, as well as shaft position, can be digitized using the same unit with other standard components. Suggested uses are in instantaneous monitoring, automatic reference recording, automatic data reduction and industrial process control. Austin Co., 76 9 Ave., New York 11, N. Y.

For more information—Circle 81, inside back cover



Perforated Tape Reader

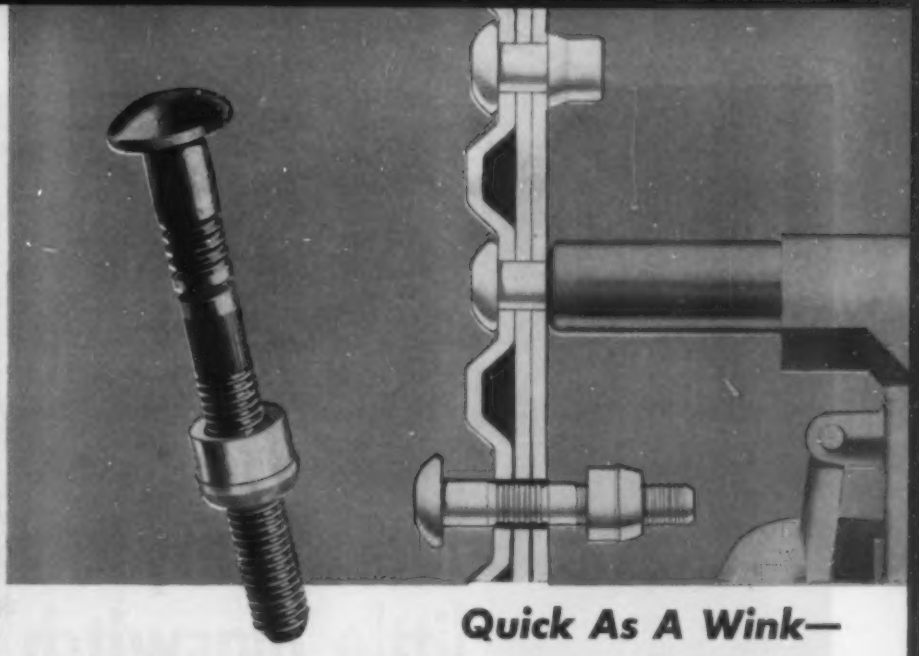
With start and stop times of 5 millisec and tape speeds up to 60 in per sec, this tape handler offers character readout up to 600 per sec. The Model 903 is said to actually stop on the stop character at speeds of 150 and 300 characters per second and on the character following the stop character at rates of 600 characters per second. This ability to stop almost instantly eliminates the need for any slowing down of the handler prior to stopping and thus increases the efficiency of the machine.

Tape widths from ½ to 1 in. and five to eight channel tape will be handled by various versions of Model 903. Potter Instrument Co., 115 Cutter Mill Road, Great Neck, N. Y.

For more information—Circle 82, inside back cover

Eight-Position Rotary Switch

Choice of detent action or snap action is provided in a multipole, rotary selector switch designed for tap, transfer or selector applications. These switches are rated at 30 amp, 230 v,



Quick As A Wink—

You Get Secure, Permanent Fastening With Townsend Lockbolts

In less than a second, with one squeeze of the trigger, a Townsend lockbolt pulls the work together with a high clinching action, is locked in place with uniform pressure. It is a quick method of producing tight, rigid, permanent fastenings that cannot loosen even under extreme vibration or shock conditions.

Townsend lockbolts combine the advantages of riveting and bolting—eliminate the disadvantages. Installation is fast—under certain conditions, one man will install 30 in only 60 seconds. Fewer workers will complete an assembly in less time than when riveting or bolting.

The clamping action, or clinch, of Townsend lockbolts is higher than rivets—is more uniform than bolts and nuts. The lockbolt fills the hole better than other fasteners, thus making possible a more rigid joint and also providing an effective liquid seal.

The Townsend lockbolt consists of two precision-made parts—a pin and a collar. Locking grooves are provided on the pin into which the collar is swaged by the pneumatic gun. The pulling section of the pin breaks in tension at a predetermined point when the setting action is completed.

Townsend lockbolts are available in steel and aluminum alloy, in 3/16", 1/4", 5/16" and 3/8" diameters, in grip lengths ranging up to 2", in various head styles. For information on how to speed production, get tight, secure, permanent fastening with Townsend lockbolts, use the coupon below.

Licensed under Huck patent nos. RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049.

THE FASTENING AUTHORITY

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry River Division - Santa Ana, California

TOWNSEND COMPANY
Sales Department
New Brighton, Pa.

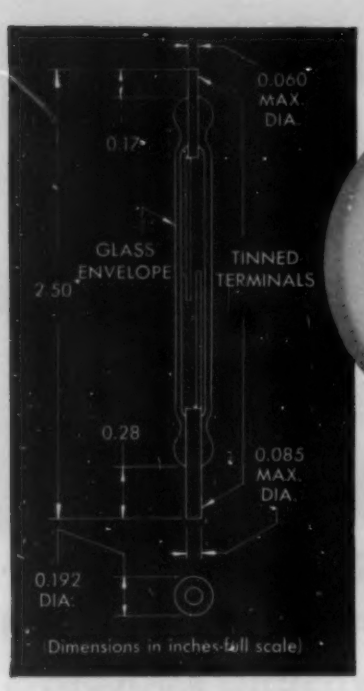
Please send without obligation "Lockbolt" Bulletin TL-101.

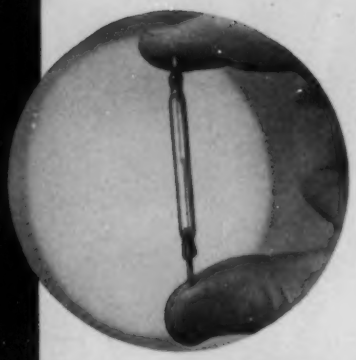
Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____





the mighty little glaswitch*

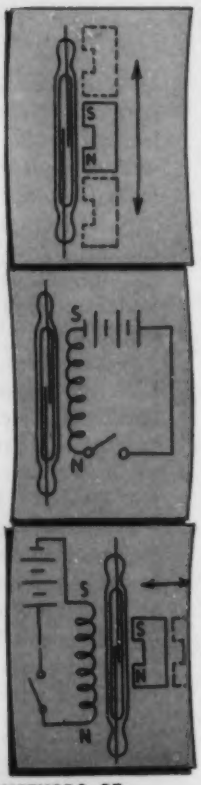
LIGHTNING RESPONSE . . . SEALED IN GLASS

The magnetically actuated reeds in this tiny Revere GLASWITCH make contact in just 1 millisecond . . . at rates up to 400 cycles per second. Hermetically sealed in an inert, dry atmosphere, with lightning fast snap action, both shelf and contact life are extremely long. Smaller than a cigarette, the GLASWITCH can be located anywhere . . . in any position . . . even in explosive atmospheres . . . individually or in multiples for multi-contact use.

Whenever you need faster, more positive response . . . where extreme sensitivity is a must . . . where light weight is important . . . investigate the Revere GLASWITCH. Write today for complete specifications and suggested uses.

CHARACTERISTICS:

Type—Single pole single throw—normally open—snap action
Enclosure—Hermetically sealed glass tube containing inert dry atmosphere
Operating Time—1 millisecond
Operating Rate—Up to 400 cycles per second
Contact Surfaces—Electroplated Rhodium
Contact Resistance (measured terminal-to-terminal)
Closed Circuit—0.050 ohms maximum
Open Circuit—500,000 megohms minimum
Contact Ratings
D.C. Loads at 28 volts
0.5 amps resistive
0.5 amps inductive (L/R—0.026)
A.C. Loads at 115 volts, 60 cycles
10 watt lamp load
Ambient Temperature Range— —85°F to +500°F



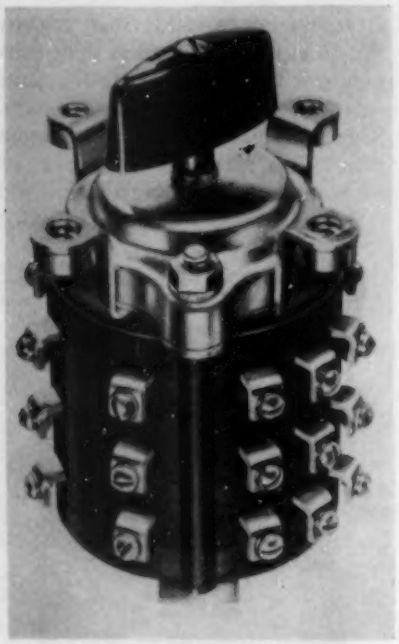
METHODS OF ACTUATION:

A moving permanent magnet or controlled external electromagnetic field are all you need . . . and the sky's the limit on imagination!

* Trademark

Revere CORPORATION OF AMERICA

WALLINGFORD, CONNECTICUT A subsidiary of Neptune Meter Company



ac, and can be furnished with up to five poles.

These switches have non-shorting knife-blade contacts wholly enclosed in molded phenolic discs. Screw terminals are provided for feeder and load contacts. Operating shafts are insulated. The required panel area, including clearance, is contained within a 4 in. circle. Electro Switch Corp., Weymouth 88, Mass.

For more information—
Circle 83, inside back cover

Terminal Blocks for UL Applications

These blocks require ½ in. spacing and they provide a full ⅜ in. creepage distance between terminals and ground. They are rated at 300 v, 25 amp. They consist of separate molded bakelite terminal sections held securely in place within the plated steel channel by brass screens. Curtis Development & Mfg. Co., 3250 N. 33 St., Milwaukee 16, Wis.

For more information—
Circle 84, inside back cover

Bladed Power Connectors

Miniature armored connectors that meet recently amended MIL-C3767 (Amendment No. 1) are rated for 125 v, 15 amp up to 250 v, 10 amp, and will accommodate cables from 0.125 to 0.450 in. dia. Government

Interior view of Motor Coach bus shows luggage racks lined with Sullvyne-Clad Metal Laminate

Actual photograph of Sullvyne-Clad sheets in Blonde Mahogany and Buffalo Grain, Ginger.

Motor Coach Industries, Ltd. selects ...

New O'Sullivan material provides attractive, wear-resistant finish for luggage racks

O'Sullivan
Sullvyne-Clad
Metal Laminate

Patents Pending

To assure greater protection against the banging, scraping and scuffing of heavy baggage, Motor Coach Industries, Ltd., Winnipeg, Canada now line the luggage racks of buses with Sullvyne-Clad Metal Laminate.

Sullvyne-Clad is a vinyl plastic sheeting bonded to metal—steel, aluminum or magnesium. It is completely flexible in application . . . can be bent, stamped, deep-drawn, punched or crimped. No special dies or drawing compounds are necessary and, since Sullvyne-Clad is pre-finished, there are substantial production savings.

Sullvyne-Clad slashes maintenance cost. The protective coating is many times thicker than any conventional finish, has unequaled abrasion resistance, withstands corrosives and the effects of heat, light and weather.

The sales appeal of the rich decorative cover of Sullvyne-Clad Metal Laminate on a product is an important market advantage. Finishes far superior to ordinary paints, lacquers or enamels can be obtained in a practically limitless variety of embossings, patterns and colors.

Wherever metal requires a decorative finish, wherever the impermanence of its present finish is causing maintenance expense or customer dissatisfaction, Sullvyne-Clad Metal Laminate suggests itself as a highly improved basic material. Find out today how Sullvyne-Clad can facilitate your production and add to the salability of your product.

METAL LAMINATE DIVISION

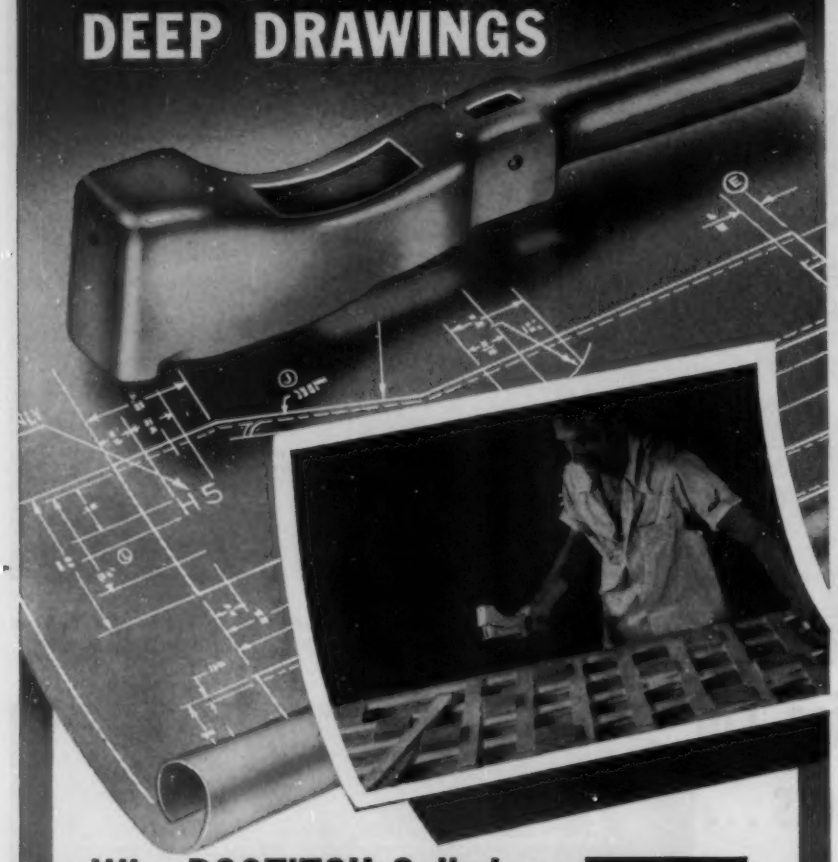
O'SULLIVAN RUBBER CORP.

WINCHESTER, VA.

Makers of America's No. 1 Heel

STANLEY

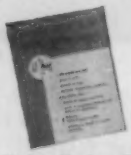
STAMPINGS, DEEP DRAWINGS



Why BOSTITCH Called on STANLEY

The Bostitch H4 Stapling Hammer, swung by a strong arm, driving a staple all the way home with each blow, takes a terrific beating every second it's in use. That's why the Hammer must be strong and tough, with no hidden flaw . . . and that's why Bostitch called on the Stanley Pressed Metal Division for the main frame of this efficient, dependable tool.

There were other requirements. The part had to be light in weight, have bearing holes extruded and surfaces suitable for plating and be produced in large quantities . . . economically. Stanley stampings solved these problems.



LET STANLEY HELP YOU SOLVE YOUR PROBLEM

Stanley stampings supplied the answer to Bostitch's problems, and can be the answer to yours. Stanley's complete facilities — its own steel mills, testing and research laboratories, product design, tool-making and finishing departments — assure that your requirements, whatever they may be, will be met.

Write Today For Free Folder "Stanley Pressed Metal Is The Answer"!

PRESSED METAL DIVISION
THE STANLEY WORKS
680-P LAKE STREET, NEW BRITAIN, CONN., U.S.A.

STANLEY TOOLS • STANLEY HARDWARE
STANLEY ELECTRIC TOOLS • STANLEY STEEL STRAPPING • STANLEY STEEL

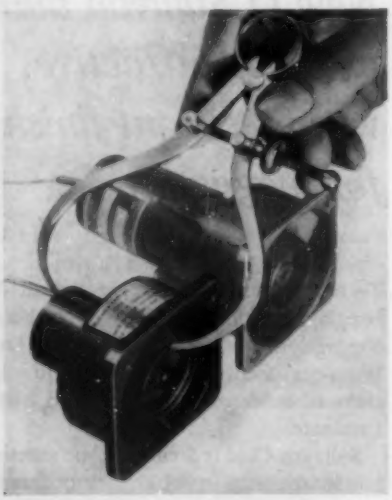
equipment specifications are said to require the use of one of these plugs on power tools, teletype machines, test equipment, soldering irons, motion picture projectors and similar devices. Automatic and Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.

For more information— Circle 85, inside back cover

Connectors for Leakproof Applications

These receptacles and plugs for hermetic glass-to-metal construction are said to insure leakproof performance under conditions of extreme heat and pressure. They were specifically intended for use in severe instrumentation problems where the vacuum tightness and arc resistance of glass were necessary. The new connectors are equivalent to MIL-C-5015. Hermetic Seal Products Co., 33 S. 6 St., Newark 7, N. J.

For more information— Circle 86, inside back cover



Miniature Axial Blower

These a-c miniature blowers are a combination of a 400 or 60 cps motor and a die-cast aluminum fan, mounted in a die-cast aluminum housing. The

40th YEAR NEWS

PARKER RUST PROOF COMPANY

PUBLISHED BY PARKER RUST PROOF COMPANY FOR THE METALWORKING INDUSTRY

On this, our Fortieth Anniversary, our humble and grateful thanks to those we have been privileged to serve during two World Wars, the Great Depression and now our period of greatest prosperity.

Parker Rust Proof Company,
R. W. Englehart, President

A LIST OF "FIRSTS" BY PARKER RUST PROOF

1. First commercial phosphate rust-proofing process (1915).
2. First high speed production phosphate rust-proofing process.
3. First process for spray application of phosphate coating materials.
4. First steel mill application for phosphate coating galvanized sheets.
5. First phosphate coating of ordnance items.
6. First substitute for tin in tin cans.
7. First phosphate coating process for wear resistance on machined elements.
8. First process for cold drawing seamless and welded carbon steel tubes.
9. First process for cold drawing stainless steel.
10. First process for cold extrusion of metal.
11. First process for treatment of metal to permit elimination of ground coat in porcelain enameling of metal (1955).

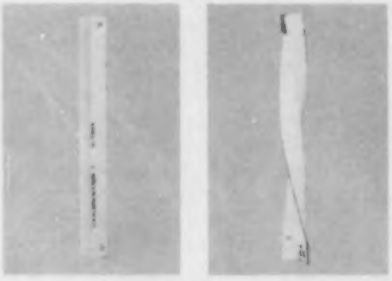
BIRTHDAY TWINS: NEW PRETREATMENT FOR PORCELAIN ENAMEL; BONDERITE WITH ICRA

Two new Parker products have been announced within a few months of the company's 40th Anniversary. One is a revolutionary new approach to porcelain enameling on ferrous metals, the other is a refinement in phosphate coating to produce more durable, more attractive paint finishes.

Parker Pre-Namel 410

This new Parker product, a pretreatment used to prepare ferrous metals for porcelain enameling, eliminates the need for a ground coat, makes it unnecessary to use premium alloys, permits application of finish coat directly on the metal.

One-coat porcelain enameling over Parker Pre-Namel 410 is simpler and more economical to produce. Durability of the finish is improved, too, as shown by standard ASTM and PEI tests. Rejects and parts for re-operation are reduced to a degree never before possible. 98% acceptance has been attained in production test runs. Plant men familiar with the product estimate that economies through Parker Pre-Namel 410 will amount to from 1 to 3 cents per square foot of enameled surface.

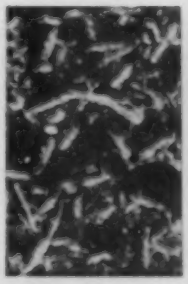


Left: Conventional two-coat porcelain enamel on enameling iron angle failed when twisted 70°. (Metal, twisted less than its elastic limit, returned to original shape.)
Right: Finish coat only, over Parker Pre-Namel 410 on enameling iron angle, withstood 240° twist before failure.

Parker Pre-Namel has been thoroughly tested for two years. It is ready now for use in production applications on the various types of articles finished with porcelain enamel.

New Bonderite Has Built-In Crystal Refining Agent

Series 800 Bonderites contain ICRA (Internal Crystal Refining Agent). This new built-in control produces a denser, finer, more uniform crystalline structure which results in improved paint adhesion and greater luster and reflectiveness.



Photomicrograph, 100X, of steel panel after phosphate treatment without ICRA. Note large crystals.

Photomicrograph, 100X, of steel panel after treatment with Bonderite with ICRA. Note fine, dense crystals.

This new series of Bonderites has the simplicity of operation and control, the uniformity of results and the over-all economy that characterizes all Parker products.

There's a formulation to meet almost every requirement of material to be treated, type of equipment and operating speed.

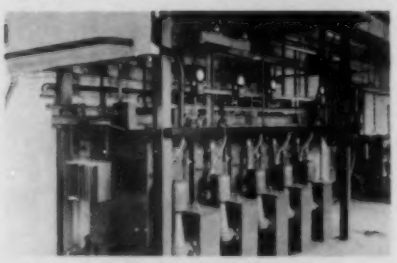
AUTOMATION IN FINISH SYSTEMS IN 1928

Automatic handling of materials through a series of operations—"automation"—is new in name only to Parker. Among the contributions of this company to the metalworking industry has been the development of straight line production, without intermediate handling, of parts through cleaning, metal preparation, dry-off and painting.

Parker's engineering department, working with conveyor and equipment companies, pioneered the first continuous dip-treatment installation in 1928, in which wheel rims were carried through cleaner, rinse and Parco Compound tanks by conveyor.

When faster-acting Bonderites were developed by Parker research, spray equipment was designed to accomodate the higher production speeds it made possible. The reduced costs and higher uniform quality, that comes with automatic operation, were made available to users of Parker Products years ahead of other automatic processing.

"GOLD STANDARD" IN PANELS FOR PAINT TESTS



This automatic machine treats panels with Bonderite on a production basis to meet the demands of Parker customers.

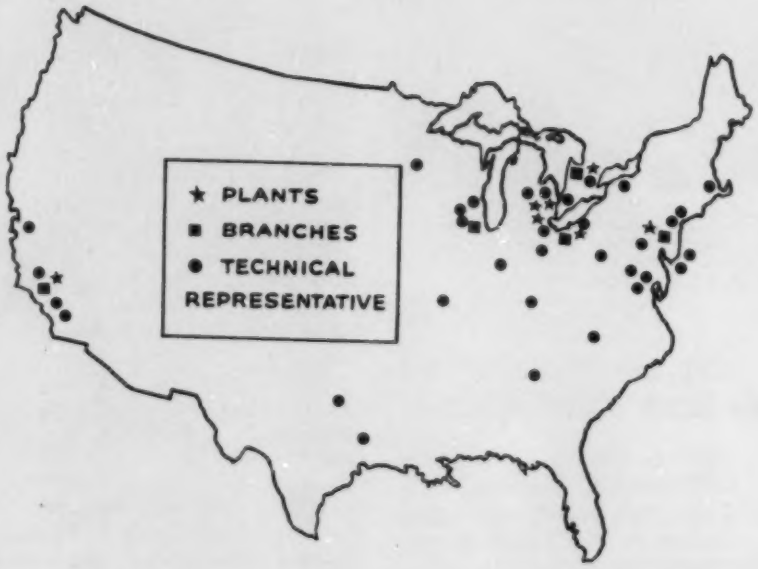
The Bonderite-treated panels prepared in Parker's service laboratories are the Gold Standard used in testing paint performance. To evaluate new paints and maintain quality control on production, manufacturers will use over one half million of these Bonderite-treated panels this year. When you use Bonderite in your plant, you are using the recognized leader in the field.

New Products, New Methods Come from Parker's Research Laboratories

There has been a research department at Parker for as long as there has been a company. In the early days it was a one- or two-man department. Now the technical staff numbers over 100. Parker research is responsible for the products and processes listed under "Parker Firsts" on the preceding page, and for hundreds of refinements and short-cuts that have meant money, time and material savings for plants throughout metalworking.

Parker's customers profit by having this imaginative, productive, and experienced research program working for them.

LOOK HOW CLOSE PARKER MEN AND PARKER PRODUCTS ARE TO YOU



Fast supply and service are important in the Parker package! The map shows coast-to-coast locations of plants, branch offices and technical representatives. No matter where you are, there's Parker service quickly available.

Parker technical representatives, backed by the most extensive know-how and experience in the industry, are themselves thoroughly experienced. The average Parker field representative has 11 years on the job!

WORLD-WIDE EXPERIENCE! Parker and its affiliates in Germany, England and France share over 125 years of experience in this specialized field.

For full information on any of the products listed below, call or write

PARKER RUST PROOF COMPANY, 2167 East Milwaukee, Detroit 11, Michigan

***Bonderite**
corrosion resistant paint base

***Parco Compound**
rust resistant

Bonderite and *Bonderlube
aids in cold forming of metals

***Parco Lubrite**
wear resistant for friction surfaces

***Parker Pre-Namel**
pretreatment for porcelain enameling

Tropical Paints
maintenance paints for industry since 1883

**Reg. U.S. Pat. Off.*

d-c blower can be furnished with any of this maker's standard windings.

These new miniature axial blowers are available with air flow in either direction. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 87, inside back cover

Reinforced Plastic Cable Clamps

Some of the advantages claimed for these clamps are: less danger of short circuit and fire because the reinforced plastic clamps will not promote contact as metal clamps do, abrasion-resistance due to the inherent characteristics of the material, and ease of installation since no plastic lining or insulation is required on the inside of the clamps. Another factor is that these clamps will endure heat. They are available in size numbers from 2 through 32 and in cable diameters from ⅛ through 2 in. Lunn Laminates, Inc., Huntington Station, N. Y.

For more information—
Circle 88, inside back cover

Silicon Power Rectifier

These rectifiers are reported to be able to do the power-conversion job of vacuum tubes 590 times their size. They will operate under shock and temperature stresses that would shatter vacuum tubes and render selenium and germanium rectifiers inoperative. Taking up 3/100 cu in. of space and weighing 7/100 oz, they have been tested to operate at temperatures as high as 200 C.

Of the diffused junction type, these rectifiers are available in six voltage ranges, capable of handling voltages as high as 1000 v, with d-c output currents on the order of 300 to 400 milliamp. Automatic Mfg. Corp., 65 Gouverneur St., Newark 4, N. J.

For more information—
Circle 89, inside back cover

Miniature Power Resistor

A 20-w miniature power resistor has an oval-shaped ceramic core on which a special alloy resistance wire is wound and silver brazed to tightly banded tab terminals. Winding is

"IDEAS IN THE MAKING WITH CIBA PLASTICS"

Hear this!

ARALDITE® 6020
with HET®-ANHYDRIDE
IMPROVES DRY LAY-UP
LAMINATING 3 WAYS...

1 HIGH HEAT DISTORTION!

Heat distortion as high as 187° C., or 369° F., according to A. S. T. M. D-648-48T, run at 264 psi.

2 SELF EXTINGUISHING... FIRE-RETARDANT!

Laminates made with this process are classified "fire retardant" under Underwriters' Flame Test on sheeting material... as "self extinguishing" according to L-P-406 b, Method 2021.1.

3 **Exceptional results achieved in applications where good mechanical strength and electrical properties at elevated temperatures are required.**

Do this!

Send for new Ciba Technical Bulletin No. 12, "Araldite 6020 with HET-Anhydride," which fully describes properties and applications of entire process.

CIBA
ARALDITE®
Epoxies

CIBA COMPANY INC. PLASTICS DIVISION PE-10
627 Greenwich St., New York 14, N. Y.
Please send me CIBA Technical Bulletin #12
ARALDITE 6020 with HET-Anhydride.

NAME_____
COMPANY_____ TITLE_____
ADDRESS_____

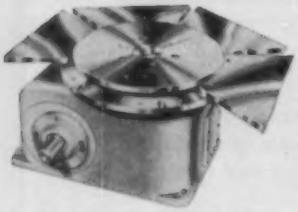
STANDARDIZED AUTOMATION!

Standard 12 stop Intermittor with specially jig-bored 36" dial.

HIGH SPEED INDEX TABLES FOR LARGE VOLUME PRODUCTION

Up to 30,000 Pieces per Hour with

The FERGUSON INTERMITTOR!



Standard 6 stop Intermittor with 12" dial and optional tool mounting brackets.

OVER 150 STANDARD MODELS TO CHOOSE FROM:

NO. OF STATIONS
4, 6, 8, 12, 16, 24, 36

DIAL SIZE
12", 18", 24", 30", 36", 48

INDEXING TIME
¼, ⅓, ½, ¾ of cycle

COMPLETE CATALOG

Every engineer should have a copy of Catalog No. 300 which gives load ratings and all dimensions of more than 150 standard Intermittors. Send for your file copy today... no obligation.

The new standard Ferguson Intermittor is a *must* for operations such as machining, joining, forming, staking, piercing, assembling, testing and inspection that require a combination of high speeds, long dwell or work time, and smooth indexing.

There is a standard Intermittor for almost every application, offering a choice of stops, dial size, degree of movement; and a table for either extreme precision or high torque usage. Seldom do you have so much selection in a line of standard production machinery... with all of the benefits of standardization PLUS many of the advantages of custom designs! The Intermittor operates at speeds far greater than those possible with other types of index tables. The special acceleration characteristics of the FERGUSON ROLLER GEAR DRIVE insure smooth starting and stopping with little shock and vibration, at speeds up to 500 indexes per minute.

Save design time, simplify tooling, improve product quality and cut maintenance costs to rock bottom with the new Ferguson Intermittor... the "Packaged" precision index table for high speed production.

WRITE FOR CATALOG NO. 300

FERGUSON MACHINE & TOOL CO., INC.

ROLLER GEAR DIVISION, DEPT. BI-10 P. O. BOX 5841, ST. LOUIS 21, MO.

sealed and protected by vitreous enamel. Non-removable solid brass brackets extend through the core supplying a convenient, simplified method of mounting. Rated at 20 w, based on 300 C rise. Stock resistance values to 50,000 ohm max, tolerance ±5 per cent. Ward Leonard Electric Co., Mount Vernon, N. Y.

For more information—
Circle 90, inside back cover

Wiring Diagrams on Adhesive Tape

Wiring diagram and other product information printed on pressure-sensitive tape are affixed directly to apparatus, instead of being printed separately in booklets or instruction sheets. The affixed diagrams cannot become misplaced or lost. Diagrams printed on both acetate film and flat-back pressure-sensitive tape are available. Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N. Y.

For more information—
Circle 91, inside back cover

Rigid Plastic Wiring Ducts

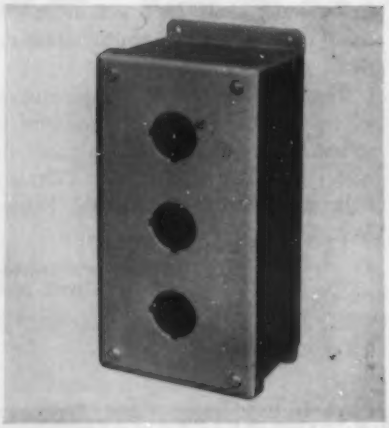
This wiring duct holds, protects and distributes a harness. Wires are simply laid in the duct and distributed through holes punched uniformly in the side. The plastic cover then snaps on or off. Holes for mounting are spaced in the bottom of the duct at 3 in. intervals.

The rigid vinyl plastic bends or forms to any shape, yet cuts easily

with a bandsaw, hacksaw, tinsnips or a pocketknife. The vinyl plastic resists the effects of acids, alkalis, greases, chemicals, or other contaminating materials, and is non-combustible.

The new wiring duct comes in 11 different sizes and in lengths up to 6 ft. It ranges in width from ½ to 4 in. and in depth from ½ to 3 in. Taylor Electric, Inc., 15400 Dale, Detroit 23, Mich.

For more information—
Circle 92, inside back cover



Oil-Tight Push Button Enclosures

Fabricated from 14 gage steel in ten standard sizes for 1, 2, 3, 4, 6, 9, 12, 16 and 25 control units, these enclosures are of all-welded construction. The cover, with a sponge neoprene gasket, is fastened to the box by four nickel-plated captive screws which thread into closed tapped holes located in the box flange. The cover has a hinge arrangement to permit it to be readily removed from the box or to be swung open for easy wiring of cover mounted control units.

The push button openings are located on 2¼ in. centers and are shaped to accommodate any standard make of control unit while retaining an oiltight seal. Hoffman Engineering Corp., Anoka, Minn.

For more information—
Circle 93, inside back cover

Small Electrical Thermostat

An electric thermostat is made in clothes dryers, electric room heaters, unit air conditioners, steam and dry

HIGH SPEED INDEXING

WHEN TO SPECIFY A FERGUSON DRIVE

IN YOUR NEW PRODUCTION MACHINERY

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Modern production methods require speeds and precision impossible to obtain with geneva drives and other obsolete indexing devices. The Ferguson Roller Gear Drive makes it possible to increase production speeds as much as 100%, *while improving product quality and reducing maintenance costs!* The Ferguson Drive, the greatest development in indexing in the last thirty years, attains indexing speeds up to 1,000 per minute in some applications without undue shock or vibration to the Drive or machine. If you have machinery utilizing dial feeds, roll feeds, carrier chains and other types of intermittent feeding methods, investigate the Ferguson Drive and discover what it can do for you.

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The more widely used Ferguson Drives may now be ordered from stock with weeks cut off delivery time and prices reduced as much as 25%. Send in the attached coupon or write for Bulletin 105a to get full information, including load ratings, dimensions and data on selecting a Drive. Find out how inexpensive it is to modernize your production machinery, increase production and lower operating costs.

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The laminations of the LAMISOL® Shim (in brass) are temporarily joined by spot-soldering on the edges. Gauges and number of laminations within one shim are unlimited.

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LAMINATED SHIM COMPANY, INC.

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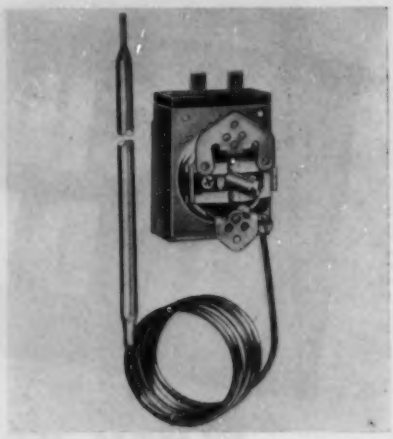


heat tables, glue pots, sterilizers, poultry brooders, egg washers.

Less than 3 in. in the longest dimension, dials, which are optional, are available in standard temperature ranges of 60-250; 100-200; 200-400 and 200-550 F. Robertshaw-Fulton Controls Co., Youngwood, Pa.

For more information— Circle 94, inside back cover

Silicon Solar Battery

This silicon solar battery is based on a hermetically sealed, large-area silicon p-n junction. It is said to provide direct conversion of solar energy into electricity, under optimum conditions, at a rate up to 10 milliwatt. Exposed to direct sunlight, the cell develops 0.3-0.5 v on open circuit and approximately 0.25 v across a resistive load of 10 ohm. The unit operates on light and not heat, and because of the inherent temperature stability of silicon, this cell is claimed to be more than 20 times more efficient than any other photovoltaic device.

The cell is small, approximately 1⅜ in. dia and it can be mounted in series or parallel with multiple cells to give increased voltage. National Fabricated Products, 2650 W. Belden Ave., Chicago 47, Ill.

For more information— Circle 95, inside back cover

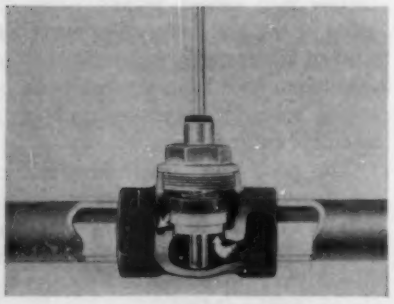
FLUID POWER AND CONTROL

Hydraulic Power Pump

This pump is said to be suitable for operating and controlling all types of hydraulic equipment. Power is controlled by two simple foot pedals, one of which applies the hydraulic pressure at any desired level. The other serves as a power release and also provides constant control while pressure decreases.

A single replaceable valve cartridge includes the main check valve, release valve and by-pass relief valve. The pump is of the two-stage, dual piston type. At low pressures, both pistons operate and produce 1 cu in per stroke. At high pressures, only one piston works. It produces a volume of 0.1553 cu in per stroke. Total potential pump discharge is 50 cu in. Maximum hydraulic pressure is 7000 psi. The pump weighs 50 lb. Columbian Vise & Mfg. Co., Cleveland 4, Ohio.

For more information— Circle 96, inside back cover



Indicates Pipe Line Flow

This indicator is designed to indicate flow (or lack of flow) of a liquid through a pipe line. Flow through the unit actuates a switch that can be used to operate a pilot light, horn or other warning signal. With relays, it will operate interlocks.

Marine bronze and plastic, chemi-

Here's How

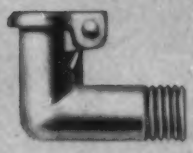
GITS

Helps Give

Built-In Low Cost To YOUR Equipment

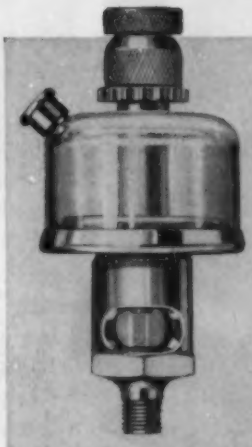
OIL HOLE COVERS

This model is designed to fit into a simple drilled hole. Ideal for use on small motors, generators, starters and light machinery—for dependable oil hole protection at moderate cost. Larger sizes frequently used as filler caps on tanks or reservoirs. Style R—No. 305.



OIL CUPS

Accurately machined from a solid brass one-piece forging, this oil cup permits safe, dependable application of lubricant at very low cost. Used widely on motors and small machinery requiring side oiling. Style L—No. 1202.

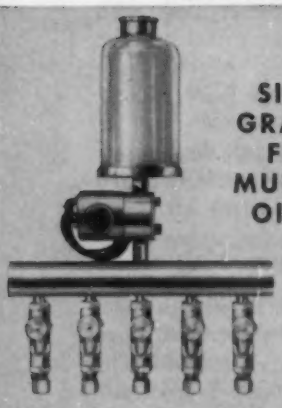


SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

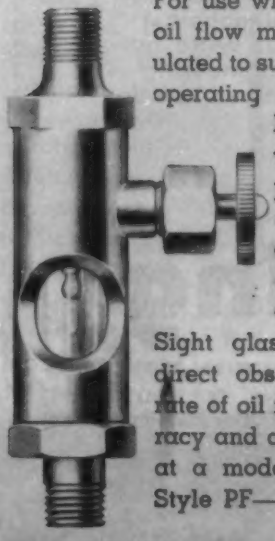
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

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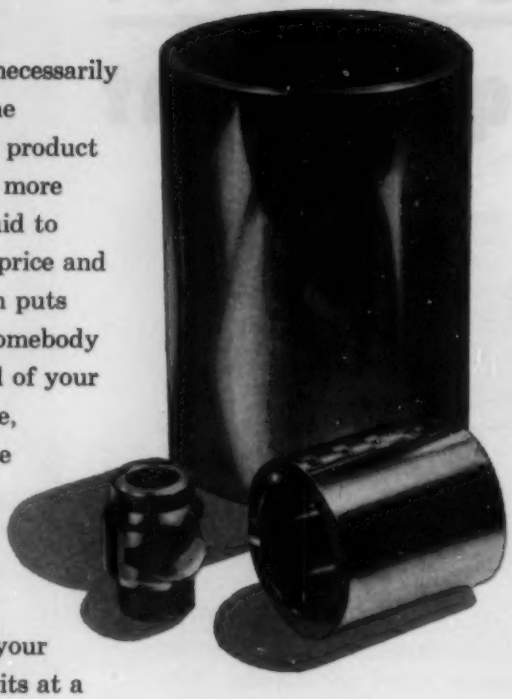
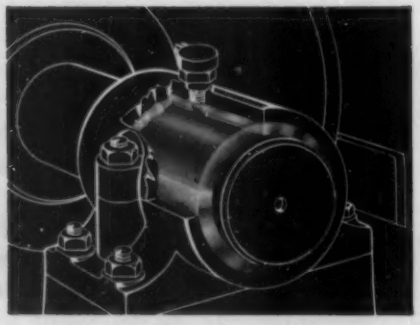


Employment of an unnecessarily expensive bearing for the "prestige" it gives your product sometimes proves to be more of a handicap than an aid to sales. It increases cost, price and service expense. It often puts the sales emphasis on somebody else's "prestige" instead of your own. The sturdy, simple, inexpensive Cast Bronze Bunting Bearing will give you maximum bearing performance at minimum bearing cost and permit you to sell your product on its own merits at a profitable low price.



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cally inert to oil, fuels and salt water, are used throughout. Lead wires are duplex nylon jacketed. The switch unit, hermetically sealed in glass, is corrosion resistant, explosionproof. The body of the flow indicator is a standard pipe fitting.

Indicators now in production accommodate standard pipe sizes from ¼ to 3 in. Normally, any flow over 1.5 gpm causes the indicator to function, but other higher or lower points can be provided on special order. Gems Co., 64 Welles Drive, Newington, Conn.

For more information—
Circle 97, inside back cover

Restrictor Valves For 3000 Psi

Available in either fixed two-way or fixed one-way types, and with either internal or external threaded ends, these restrictor valves have a wide ambient temperature range of —65 F. to 275 F. They weigh 20 to 35 per cent less than conventional models. The fixed two-way type, which provides precise flow metering in both directions, contains a fixed orifice in the center and 0.008-in. mesh corrosion resistant filters on either side. The fixed one-way type, which meters in the restricted flow direction and permits full line flow at low pressure drop in the free flow direction, contains a poppet with orifice equipped with an integral filter. Poppets and interior parts in all models are corrosion resistant.

Series 1100 restrictors are available with either aluminum, stainless steel or special alloy bodies and with threaded ends for the following tube sizes: ¼, ⅜ and ½ in. Aircraft Products Co., 300 Church Road, Bridgeport, Pa.

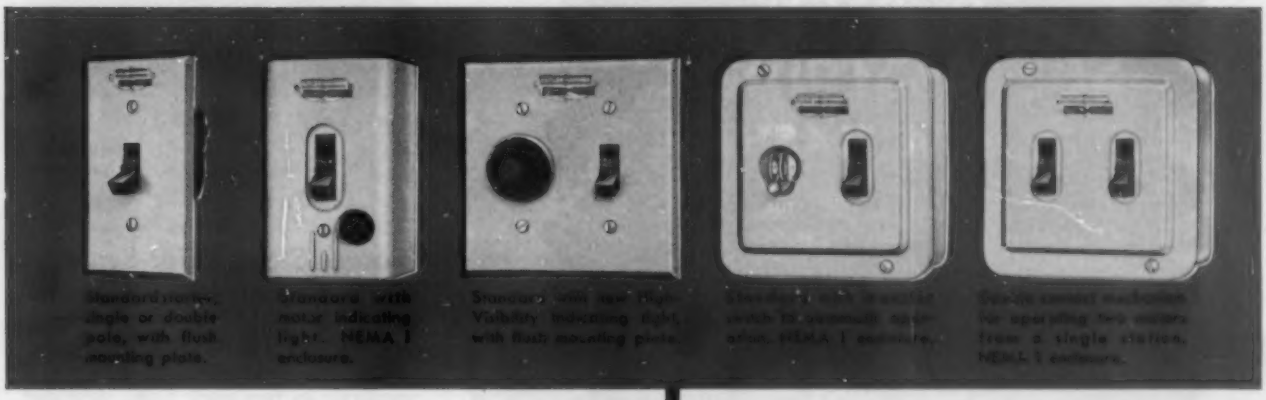
For more information—
Circle 98, inside back cover

Heavy-Duty Cam Valve

A cam valve with larger cam roller and cam plunger for increased bearing surface has been introduced. The plunger spring is loaded to take care of over travel on stroke and all working parts and is completely sealed by means of a synthetic boot and otherwise sealed against external contami-

Now-the 9101 "Family"

The Cutler-Hammer Line of fractional horsepower manual starters now includes new mechanisms, new styling, new uses

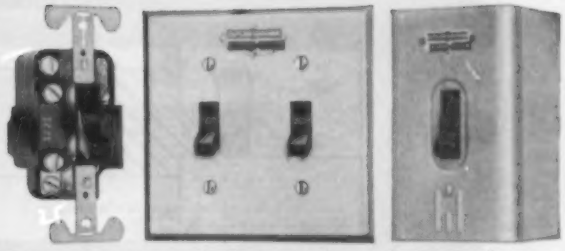


In order to meet the ever-growing needs of the market with a starter of proven design, Cutler-Hammer now brings out a complete family of Bulletin 9101 Manual Starters for fractional horsepower motors.

This family now includes the standard starter with motor-running indicating light, with standard or with high-visibility lenses. It now includes a standard switch together with transfer switch to automatic operation with padlocking provision. It now includes a "2 in one" model, two starters in one case for controlling 2 motors from a single station.

Another feature of great interest is the optional brushed stainless steel flush plate for installations such as hospitals, modern office buildings, etc. Conventional finish is gray baked enamel on a bonderized undercoat.

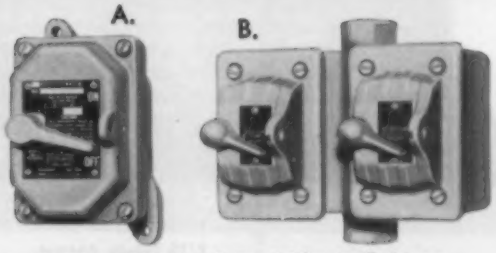
9101 starters are available for mounting in a standard Gem or Handy outlet box; for flush mounting; for surface mounting. The 9101 is a high-quality line at no premium cost. Its features include single or double pole, quick make and break silver contacts; eutectic alloy overload protection; straight-through wiring; wrap around covers, etc., etc. Available at your authorized Cutler-Hammer distributor. CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.



Open type, mounting in Gem or Handy outlet box.

Skeleton starter with flush-mounting plate.

Enclosed surface mounting construction.



A. Starter in NEMA 7 or 9 Special Service Enclosures.

B. Duplex starter in NEMA 4 or 5 Special Service Enclosure.

CUTLER-HAMMER
MOTOR CONTROL
C-H

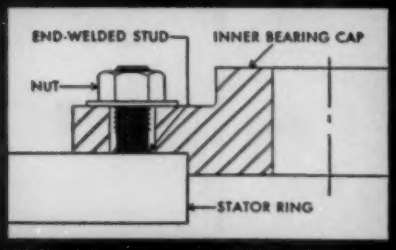
"STUD" NELSON ATTACHES

SUB-ASSEMBLIES IN A FLASH!

Easy does it . . . a NELWELD® gun makes the placing of attachment studs a simple operation . . . takes the tool to the work . . . cuts costly material handling . . . eliminates drilling and tapping.

Studs stay put! . . . NELSON® welded studs fuse with the parent piece to become an integral unit, equally strong at the weld.

Trigger fast, too! . . . push a button and you've got a weld.



. . . just a few reasons why the NELWELD system is the practical way to attach fixtures, brackets, bearings, accessories, pillow blocks, and endless sub-assemblies.

A corps of Nelson experts is trained to help co-engineer better fastening with inevitable cost reduction. And the Nelson network of factory warehouses blankets the country . . . puts studs, equipment, and rentals right in your own back yard! Write for details.

Stud Nelson

Fasten it Better at Less Cost with

NELWELD

NELSON STUD WELDING
2752 Toledo Avenue
Lorain, Ohio

Please send more information on stud welding sub-assemblies and other applications.

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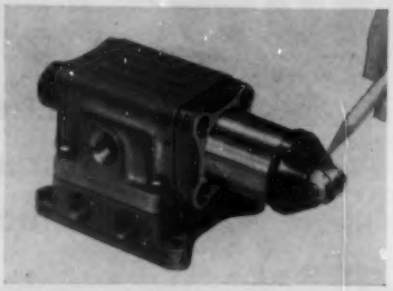
NELSON STUD WELDING DIV. OF GREGORY INDUSTRIES, INC. LORAIN, OHIO



nants. Available in ⅜ in. three-way and four-way models. Mechanical Air Controls, Inc., 10030 Capital, Oak Park, Detroit 37, Mich.

For more information—
Circle 99, inside back cover

Forged Steel, Inside-Screw Gate Valve

Rated at 800 lb and 800 F, the Type 652 rising-stem gate valve is available in two sizes, ¼ in., weighing 18 oz, and ⅜ in., weighing 17 oz. Worcester Forged Steel Valve Co., 16 Parker St., Worcester 10, Mass.

For more information—
Circle 100, inside back cover

Automatic Hydraulic Valve

A single-solenoid, pilot-operated hydraulic valve for automatic control of hydraulic circuits is the sub-plate type for panel mounting. It is designed for full 3000 psi. Available in ½, ¾, 1, 1¼ and 1½ in. sizes, the new valve meets all JIC requirements and has a full capacity rated at 3.6 gpm at 15 fps. Low pressure drop permits this valve to operate at maximum efficiency.

The new solenoid is heavy, continuous duty type and operates on 3.6 amp inrush and 0.45 amp holding at 115 v. Rivett Lathe and Grinder, Inc., Brighton 35, Boston, Mass.

For more information—
Circle 101, inside back cover

All Brass Valve

This valve is 3 x 2 in. To change position of its lever, it must be lifted as well as turned for it to drop into the proper slot. Design features include an O-ring seal on the stem shaft, and forged handle, cap, and bonnet. The unit is available only in

¾ in. size. It is applicable to piping systems or applications requiring two-position or three-position control of three-way and four-way circuits. Aquamatic, Inc., Rockford, Ill.

For more information—
Circle 102, inside back cover

Hydraulic Shut-off Valve

The overall dimensions of this valve are 4.67 x 2.03 x 3.5 in. high. It can be supplied in tube sizes from ¼ to ½ in. Some of the other features are low current drain, explosionproof, operating range 0 to 5000 psi. Temperature range is —65 to 275 F. Flow rates are from 0 to 10 gpm. Mar Vista Engineering Co., 5420 W. 104 St., Los Angeles 45, Calif.

For more information—
Circle 103, inside back cover

Full-Port, Normally Closed Solenoid Valve

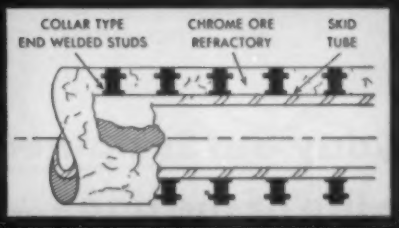
This valve, which does not require back pressure in its operation, will operate and hold fully open, with low or no flow pressure at all. The valve is said to have proved itself capable of handling gas at low as well as higher pressures induced by gas boosters and air blowers. It has also been established for use on vacuum lines and in the control of liquids in a wide range of viscosities. Temperature limit in the latter application is 212 F, static rating is 150 psi.

This packless valve has a bronze valve body with screwed ends in sizes 1 to 3 in., with single-seat, full-size

"STUD" NELSON
END-WELDS
INSULATION STUDS
IN A FLASH!

Encountering difficulty or high cost in securing or supporting insulation efficiently? If so, take a good look at the NELWELD® method.

NELSON® studs, end-welded in a split second, have solved hundreds of insulating problems for steel mills, all types of processing plants, and for manufacturers of boilers, heating and air conditioning equipment and tanks.



The NELSON collar stud, illustrated, is only one of many types that make insulating practical and profitable. Pins, hooks, rectangular studs, eye-bolts, split and slotted studs . . . fasteners for any kind of insulation . . . open up design possibilities without limit.

Your Nelson Field Engineer is a fastening expert, experience-trained to analyze your product designs at the blueprint stage . . . the point where remarkable savings can be realized. Write for details, indicating your problem.

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Please send more information on securing insulation and other cost-saving NELWELD applications.

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Helicoid Gages

For day-in, day-out Sustained Accuracy —for the life of the gage— HELICOID Quality costs you less!

• It's the basic design of HELICOID Gages that makes them outlast and out-perform ordinary gear-tooth gages. This enduring accuracy is evidenced by the smooth rotation of simple spiral roller and cam.

If you use gages it will pay you to investigate HELICOID performance records. There is a HELICOID long-life gage to meet every type of pressure indicating requirement. Ranges are to 20,000 p.s.i. and vacuum or compound.

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Dials may be black, white or radiant.

Wall or stem mounting cases—flush panel or flangeless cases.

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Pressure • Vacuum • Compound

valve port. A renewable resilient valve disc mounted in a bronze holder extends into an auxiliary piston and the pilot valve is also equipped with a resilient disc. Magnatrol Valve Corp., 71 Fifth Ave., Hawthorne, N. J.

For more information— Circle 104, inside back cover

Electrically Actuated Hydraulic Servo Valves

These valves are available for 500 to 2000 psi hydraulic systems. Controlled maximum output flows are 0 to 9 gpm with a time constant of approximately 1½ millisec, from input differential current to output flow. The valves can be provided with various manifold configurations, coil inductance and resistance requirements in the same basic envelope or to meet individual specification. The valves weigh less than 1 lb. These valves are designed with a steel body and integral steel inserts. Bendix Aviation Corp., N. Hollywood, Calif.

For more information— Circle 105, inside back cover

Needle Valves for Small Flows

Needle valves are available in five orifice sizes and four pipe sizes in both angle and straight type. They are designed with a long taper on the working part of the needle and a fine thread on the stem. Available either with or without a panel mounting flange, sizes range from $\frac{1}{16}$ to $\frac{3}{8}$ in. and pipe sizes are from $\frac{1}{8}$ to $\frac{1}{2}$ in.

Body castings are of valve bronze and valve needles are 18-8 stainless steel. Valve bodies constructed of

HOWELL MOTOR BRIEFS

Quick facts for those who apply and specify electric motors

New Stator Design is a Motor Life Saver!

One sure way to save years of motor life is to provide a better means of removing excess internal heat. That's what has been accomplished by the new stator lamination design developed for the Howell Series 100 motors.

Instead of the conventional smooth outer surface, this stator has wide ventilation slots in its circumference. With the dividing "fins" fitted against the motor frame, air passages are created that put 50% more stator heat transfer surface in direct contact with the flow of fan-driven air.

Copper-clad rotors shed heat faster, too

Rotor slot bars and end discs are a bonus feature of all Howell motors. Note below right the much greater thermal conductivity of copper, as compared to aluminum, the metal in common use for cast rotors today.

Significantly better heat dissipation is one of the reasons why Howell engineers, in designing for the new frame sizes, came up with such an outstanding group of motors in the new Series 100. They are not only smaller and lighter, they're cooler running than their horsepower equivalents in the old frame sizes.

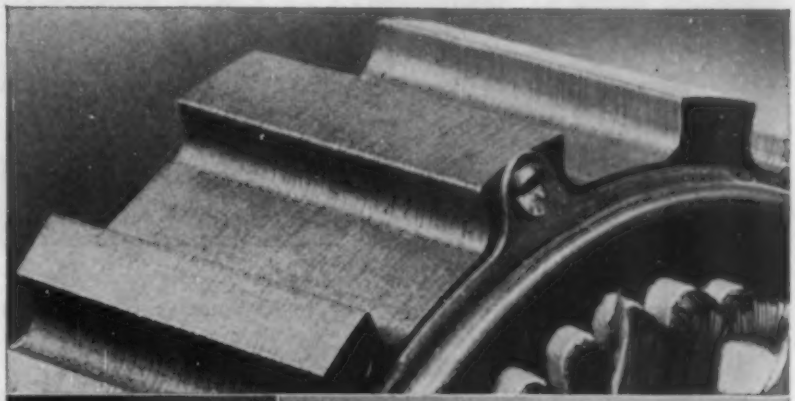
Why not go modern in motors?

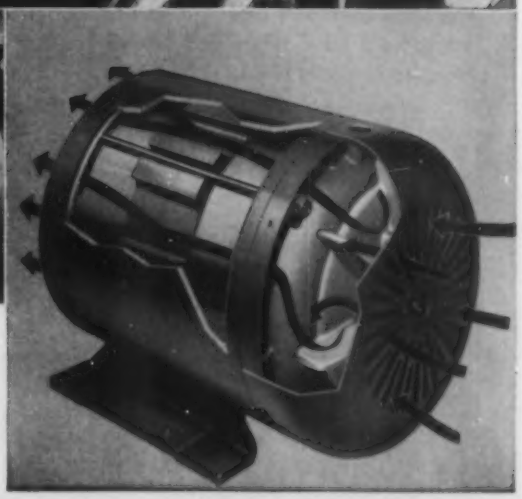
Fact is, you really can't afford to pass up the Howell Series 100 Rerated motors without investigating their potentials for your machine modernization programs. They give you space savings, weight savings and new, sleek good looks — along with construction features like these: Mylar-lined slot insulation, fully protected cartridge type bearings, resilient steel frames and mounting feet, and permanently position-identified leads. These are a few of the gains; let us tell you about the rest.

Series 100 enclosures: totally enclosed fan cooled, open drip-proof, splash-proof and weather protected, sanitary, explosion-proof, and totally enclosed non-ventilated.

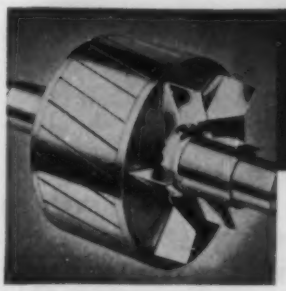
See our catalog in Sweet's or write for copy

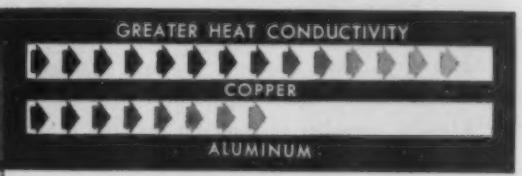
Write for new Bulletin N-100-R





Illustrations above and at right show the first real advancement in motor ventilation in years — made possible by the slotted stator design of the new Howell Series 100 motors.





The thermal conductivity (K factor) of copper is 91% greater than that of aluminum. Copper's electrical resistivity is 35% less. Two good reasons for Howell's use of copper-clad rotors in Howell Series 100 motors of *all* horsepowers.

HOWELL Red Band MOTORS

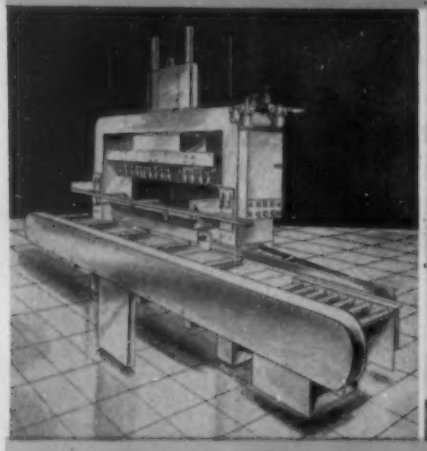
HOWELL MOTORS

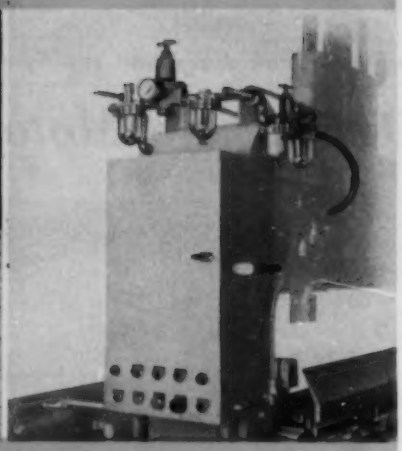
HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

Norgren PRESSURE REGULATORS

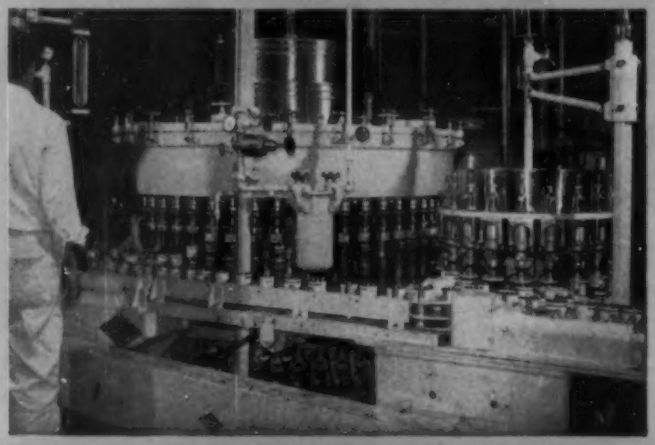
for accurate control of automatic machines





NEW-MATIC UNCASER This machine automatically removes empty bottles from cases at a maximum rate of 432 bottles per minute. Six double-acting air cylinders do the work. Accurate air pressure control is provided by three Norgren Pressure Regulators.

Dependable air line filtration and lubrication are provided by Norgren transparent bowl filters and lubricators. For complete details, write for Norgren Blueprint No. 123.



CANNING MACHINE This beverage canning machine at White Rock Canning Company, Denver, Colorado, uses a Norgren ½" Pilot-Controlled Pressure Regulator to control air pressure in the reservoir. Extreme accuracy of reservoir pressure is necessary to provide consistency in filling cans to a predetermined level.

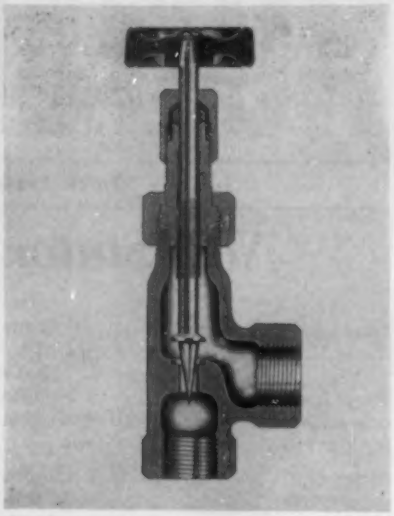
You, too, can have dependable pressure regulation with Norgren quality regulators.

A Complete Line of Pressure Regulators — NEARLY 400 STANDARD MODELS

...plus many others designed to meet specific job requirements

Write for complete data on Norgren Regulators or phone the Norgren representative listed in telephone directory classified section under Norgren Pneumatic Products

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.



stainless steel are available on special order. Ideal-Aerosmith, Inc., 12909 S. Cerise Ave., Hawthorne, Calif.

For more information— Circle 106, inside back cover

Large Diameter Hydraulic Cylinders

This line of hydraulic cylinders comes in 5, 6, 7 and 8 in. bore size. They are made of heavy-wall, seamless steel tubing, bored and honed to a mirror finish and cover a range up to 36 tons at working pressure from 1000 to 1500 psi. Heavy-duty cast iron pistons and rings with V-type packing and easily adjustable glands are standard. Single or double acting, they are available with threaded, plain or pin-eye rod fittings and cylinder mountings. Wisconsin Hydraulics, Inc., 3165N. 30 St., Milwaukee 16, Wis.

For more information— Circle 107, inside back cover

Oil-Hydraulic Power Units

These pipeless packages conform to JIC recommendations and include electric drive motors meeting new NEMA frame size specifications. They are recommended for use with systems requiring operating pressures up to 1000 psi.

Series T8 power units consist basically of an electric drive motor, an oil-hydraulic pump and a control circuit, mounted on an 8-gal reservoir. Three pump capacities are available, 2.2, 3.7 and 5.2 gpm rated deliveries at 1800

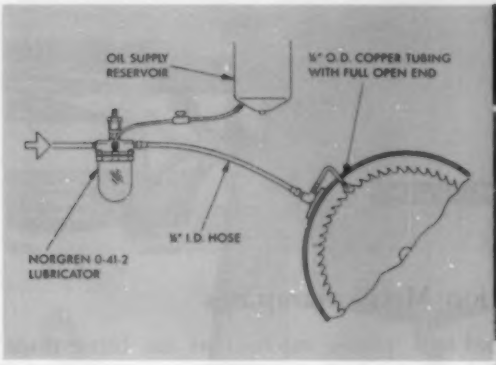
Norgren Oil-Fog Lubrication *increases saw blade life* 20 times

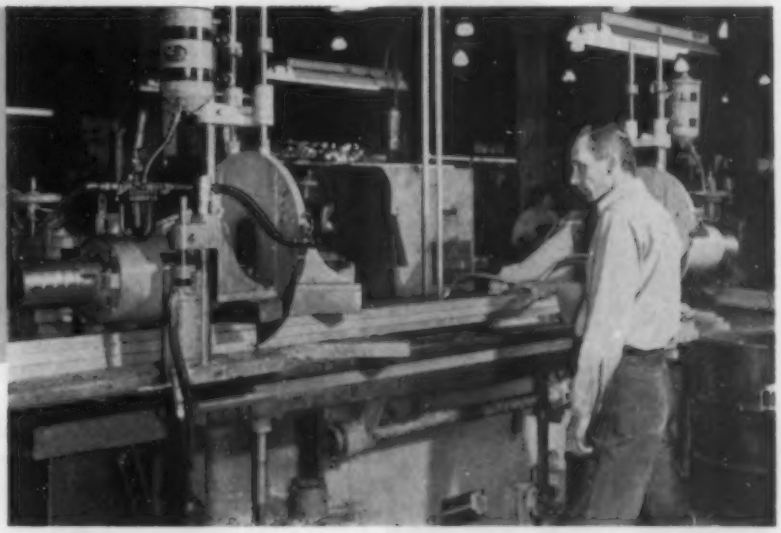
AT ALUMATIC CORPORATION OF AMERICA

This prominent manufacturer of aluminum storm doors and windows uses Norgren Oil-Fog Lubrication on 16" circular saws for cutting to length extruded aluminum bars and shapes. The extrusions are 2½" to 4" wide and are generally stacked 3" to 4" high for simultaneous cutting.

Saw blade life expectancy was approximately 8 hours with the previous manual lubrication system, and burrs at the cut ends were excessive. With Norgren Oil-Fog Lubrication for each saw blade, the blade life has been increased to 3 to 5 weeks. A manual operation has been eliminated. Smoother cuts are obtained, burrs practically eliminated.

The Alumatic Corporation uses Norgren lubricators exclusively for the lubrication of pneumatically operated equipment.





A ¼" Norgren lubricator is used to lubricate each saw blade. The lubricant is a specially compounded cutting oil used at the rate of 3 fluid ounces per hour per blade. A cam-actuated spring loaded valve permits continuous spray application for heavy cuts and intermittent application on light cuts.

For complete details on this Norgren Oil-Fog application, write for Norgren Blueprint No. 122, or phone the Norgren representative listed in your telephone directory, classified section under Norgren Pneumatic Products.

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

rpm and zero pressure. A choice of three electric drive motors is provided, rated 1, 1½ and 2 hp at 1800 rpm. Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

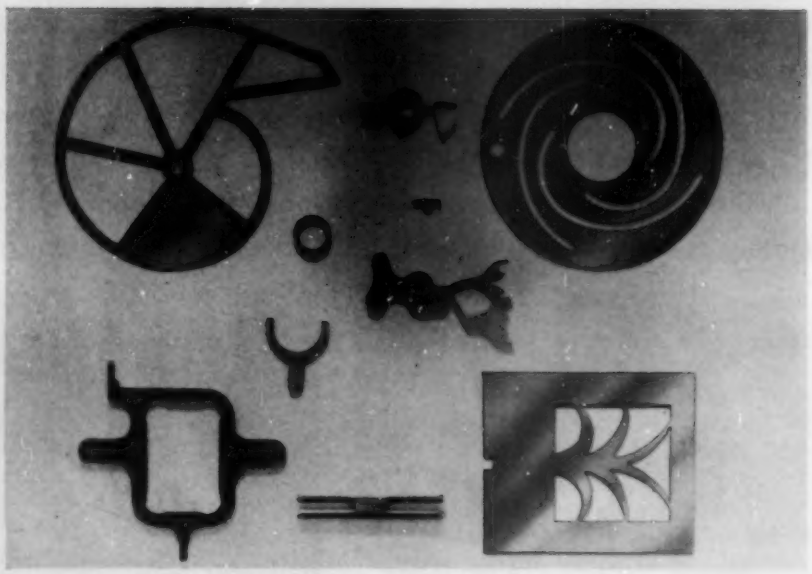
For more information—
Circle 108, inside back cover

Ball Joints for Piping

Ball joints in 8, 10 and 12 in. sizes are now being offered for power, process, heating, chemical and hydraulic service. Flanged end and welding end patterns may be ordered in all three sizes in wrought steel or castings. Flanged end joints are available with 150 or 300 lb flanges. Joints with welding ends are suitable for 600 psi steam and operating temperatures up to 1000 F. The newly introduced joint allows 15 deg angular flex. Barco Mfg. Co., Dept. J-15, 500 Hough St., Barrington, Ill.

For more information—
Circle 109, inside back cover

ENGINEERING MATERIALS



Thin-Section Metal Stampings

Metal pieces are being stamped out of sheet steel, brass and aluminum by a stamping process with lateral sections thinner than the metal sheet stock from which they are stamped. Flat pieces or three-dimensional parts are produced as desired.

Intricate cams and other parts for precise mechanisms are being made as well as non-moving parts, letters of the alphabet, trademarks, insignia and decorative designs. Federal Tool & Mfg. Co., 3600 Alabama Ave., Minneapolis 16, Minn.

For more information—
Circle 110, inside back cover

Plastic Coated Steel Tape

This product is basically a high tensile steel strap like that used for heavy packing. Over this is extruded any of three plastics: vinyl, nylon or polyethylene, the plastic forming a thick coating that protects the metal from corrosion.

Among advantages claimed for this tape is that it combines the strength of steel with the dielectric properties, abrasion resistance and other service factors of the plastic coating. It can be fastened by bolts or rivets or—by stripping a section of the plastic to expose the metal—it can be spot welded. Coatings are available in any

BACK IN THE 1880's

WHEN THE SALVATION ARMY FIRST ESTABLISHED AMERICAN HEADQUARTERS

Koven

WAS MAKING INDIVIDUALIZED EQUIPMENT PARTS

PLANTS:

Jersey City, N. J.

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Today the good works of the Salvation Army are famous throughout the country. Yet as far back as the days when only eight dedicated men and women comprised the entire American Salvation Army, leading manufacturers were already using Individualized Parts built by KOVEN.

Through the years, KOVEN Individualized Equipment Parts—tailored to the exact needs of an operation—have earned a unique place in an industry geared toward dependable, fast-paced output. That is because KOVEN, one of America's largest steel fabricators, has the know-how to build the special parts required for more efficient output—and can usually do the job faster and at lower cost than you could in your own plant. Call or write for a consultation with a trained KOVEN representative. No obligation. Send for Bulletin #550.

Specialists in intricate fabrication using:

- **stainless steel**
- **monel**
- **nickel**
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Fabrication to all A.S.M.E. Codes

X-Ray Inspection **FOR QUALITY CONTROL**

Our complete modern facilities include: Machine, welding, plate and sheet metal, galvanizing and welding shops.

L. O. KOVEN & BRO., INC.
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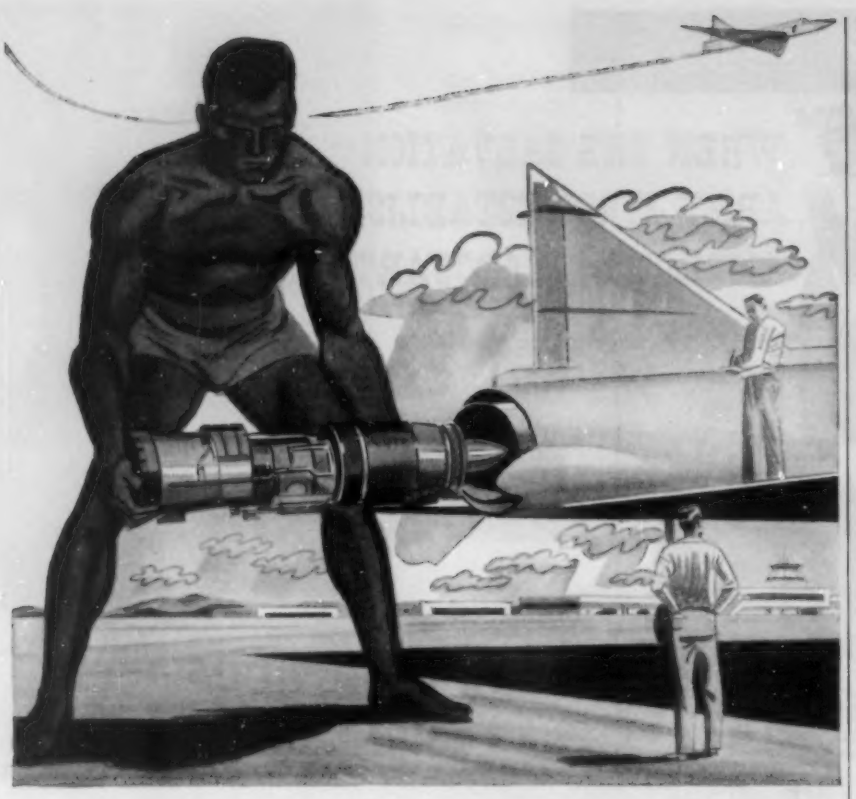
KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881



BABY TENDER
for 4 tons of
THUNDERBOLTS

The "baby" in this case is a jet engine for an Air Force fighter —8,000 pounds of super-precise, highly adjusted mechanism that must be lifted from the ground and carefully "threaded" into the needle's eye of the fighter fuselage.

Or the baby may be an x-thousand-pound super bomb that is lifted, transported, then hoisted into the bay of an interglobal bomber.

For jobs like these, Cleveland Pneumatic is designing, engineering, and building a variety of special ground-handling equipment. The experience we have in hydraulics, pneumatics, and actuating mechanisms is being used successfully on all this giant equipment.

If you have problems that involve moving, hoisting and juggling unusual sizes and shapes, and if ordinary methods haven't solved them, let our Special Devices Division work on them.

Because each of these problems requires its own custom-design solution, no literature is available. But we'll welcome your inquiries.

Cleveland Pneumatic
Tool Company CLEVELAND 5, OHIO

Department E-1055
3781 East 77th Street • Cleveland 5, Ohio

BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS
AIRCRAFT GROUND HANDLING EQUIPMENT

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

color and can be heat sealed at the cut ends. Garrison Co., 218 Front St., S. Plainfield, N. J.

For more information—
Circle 111, inside back cover

Leaded Round Steel Bars

The addition of minute particles of lead (0.15-0.35 per cent) to standard SAE 52100 steel is said to result in freer machining and faster cutting. The lead acts as a lubricant, reducing friction between tool face and chip.

The addition of lead does not appreciably affect the basic characteristics of 52100 steel. Hardenability, tensile strength, ductility and impact strength are unchanged. Leaded 52100 is heat treated the same way as unleaded material, and may be used in tools, gages, bushings, flanking, forming and draw dies, collets, pins, rolls, spacers, cutters and other machine parts. Peterson Steels, Inc., Union, N. J.

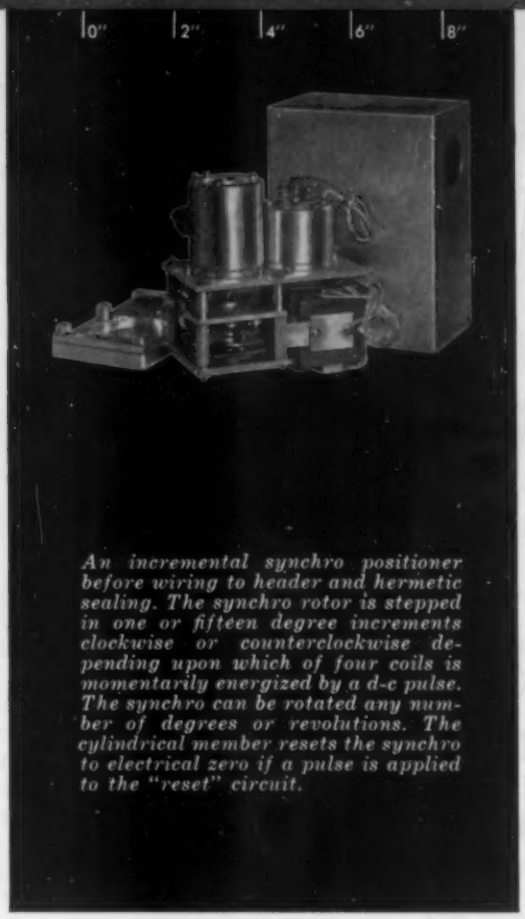
For more information—
Circle 112, inside back cover

Extruded Plastic Tracks For Sliding Panels

Made of a high-impact, modified polystyrene plastic, these tracks are reported not to chip, warp, splinter or rust. They are constructed with special convex platforms to reduce friction and provide effortless gliding ease without the use of rollers. They are available in single, double, and triple

built to do just one servo control job . . .

perfectly



An incremental synchro positioner before wiring to header and hermetic sealing. The synchro rotor is stepped in one or fifteen degree increments clockwise or counterclockwise depending upon which of four coils is momentarily energized by a d-c pulse. The synchro can be rotated any number of degrees or revolutions. The cylindrical member resets the synchro to electrical zero if a pulse is applied to the "reset" circuit.

Like all Transicoil servo assemblies, this incremental positioner "does the job right" because it was designed for a single application . . . by a company whose major function is to provide complete servo assemblies precisely engineered and manufactured to solve individual servo control problems.

Of course, if you merely want servo *components*, you'll find Transicoil's control motors, motor-gear train combinations, motor-gear train-generator combinations, and servo amplifiers built to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

That's why it pays to check your servo problems out with Transicoil first. Write outlining your problem, and ask for Transicoil's new gear-motor bulletin. You'll find it a mighty handy availability guide in designing for tight production schedules.

Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

Model A 23 Calivolter

Calivolter now available for immediate delivery

NEW CALIDYNE'S CALIVOLTER*

WHAT THE CALIVOLTER IS

The Calivolter is a precise electrical instrument which provides an accurate voltage output over a wide frequency range. True r.m.s. voltages regardless of waveform, and accuracy of ±½% are outstanding features. The Calivolter fills a long recognized need for an extremely accurate but inexpensive voltage standard.

*Trademark

WHAT THE CALIVOLTER DOES

The Calivolter may be used to measure accurately the e.m.f. of voltage-producing vibration, pressure, and seismic pick-ups, as well as strain-measuring devices. It provides a means for accurately calibrating voltage detectors and voltage-sensitive devices such as Vacuum Tube Voltmeters, Oscilloscopes and Sensitive Relays. It may also be used for over-all calibrations of Recording Systems, and for measuring the frequency-response of Amplifiers, Recording Systems, Transformers, High Impedance Meters, etc.

WHAT THE CALIVOLTER OFFERS

Here are some of the advantages and features which you get with the Calivolter:

- *Accuracy ±½% from DC to 10KC — useful to at least 20KC.*
- *Voltage output from 10 microvolts to 10 volts in 5 continuous ranges.*
- *Easy operation, simple standardization.*
- *Low output impedance — max. 1000 ohms.*
- *No current waveform error.*
- *Current output — 1 microamp to 10 ma in decade steps.*
- *A transfer switch and input connection for "unknown" facilitates measurements by substitution.*
- *Small size (8" x 8½" x 4" o.a.)*
- *Lightweight (6¼ lbs.), sturdy construction, matchless quality.*

Write today for specifications and price.

THE CALIDYNE COMPANY

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

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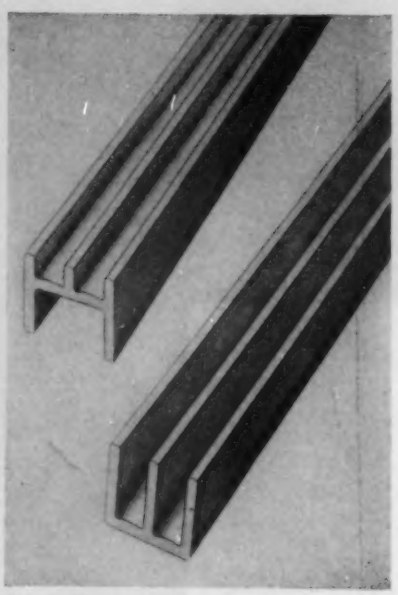
CANADA Measurement Engineering Ltd. Arnprior, Ont. Phone 480 Toronto, Ont. Alcyfair 6060
EXPORT Radio International Corp. 12 East 40th St., N. Y. 16, N. Y. Murray Hill 9-0280



tracks—top, side or bottom. Several standard shapes are available. Color choice is practically unlimited and tracks can be supplied cut to exact lengths ready for assembly. Anchor Plastics Co., Inc., 36-36 36 St., Long Island City 6, N. Y.

For more information— Circle 113, inside back cover

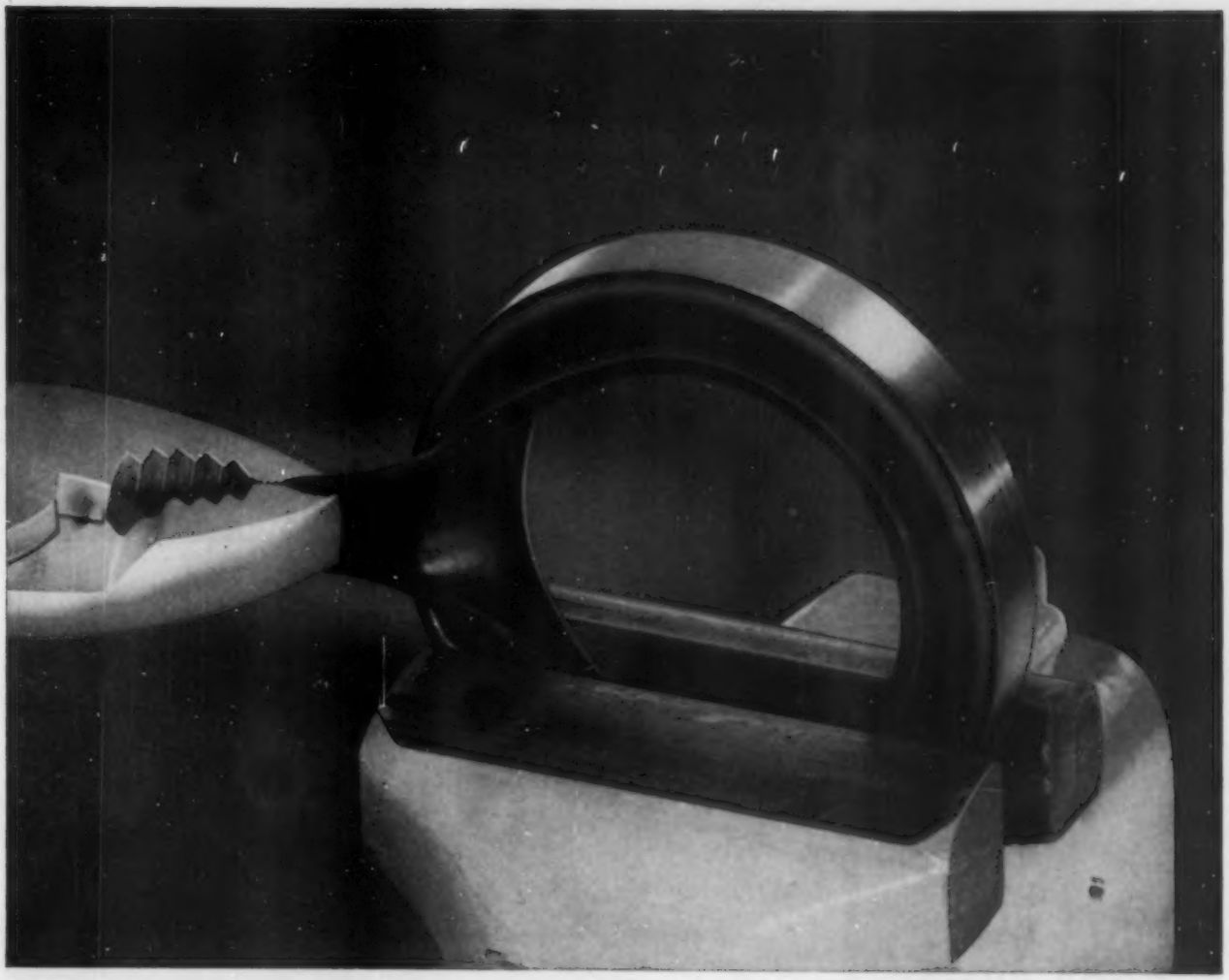
Epoxy Finish For Metals

This finish can be applied directly to any clean metal surface without a prime coat, has exceptional adhesive qualities, has an extremely hard surface yet is flexible and is said not to crack or chip under impact or bending. It may be applied by brush, spray, applicator or dipping. It is a two-conponent finish that is mixed in equal parts as required. When mixed, it has a very low viscosity which is maintained in the container for several hours with little change, yet when applied it air dries dust free in 30 min and can be handled in 120 min. Minnesota Platon Corp., Pipestone, Minn.

For more information— Circle 114, inside back cover

Cold Punching Laminate

An electrical grade phenolic laminated plastic which can be punched at room temperature is now available. The material is particularly suited for copperclad printed circuits where automatic process-s require registration



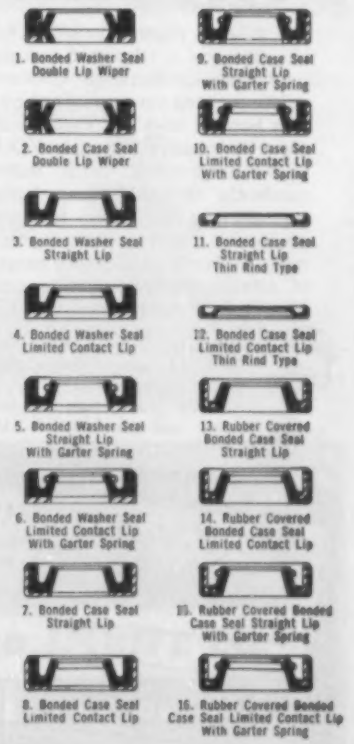
PULL IT . . . TWIST IT . . . STRETCH IT

Bonded IPC Packings Stay Bonded

Here's proof that "Bonded by IPC" means absolute adhesion . . . rubber to metal. Exerting more stress would only result in bending the metal case, or in tearing the synthetic rubber, but the IPC bond between will not break down.

Case seals and bonded washer seals will probably never face such grueling strain in actual use . . . but the fact remains . . . they could.

Whatever your sealing problem, you can rely on IPC packings. They will be custom designed and IPC experience assures low cost dependability.


1. Bonded Washer Seal Double Lip Wiper
9. Bonded Case Seal Straight Lip With Garter Spring
2. Bonded Case Seal Double Lip Wiper
10. Bonded Case Seal Limited Contact Lip With Garter Spring
3. Bonded Washer Seal Straight Lip
11. Bonded Case Seal Straight Lip Thin Rind Type
4. Bonded Washer Seal Limited Contact Lip
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
5. Bonded Washer Seal Straight Lip With Garter Spring
13. Rubber Covered Bonded Case Seal Straight Lip
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
14. Rubber Covered Bonded Case Seal Limited Contact Lip
7. Bonded Case Seal Straight Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
8. Bonded Case Seal Limited Contact Lip
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

P4

IPC **INTERNATIONAL PACKINGS CORPORATION**

Bristol, New Hampshire

• A good chair is like a good wife...if you choose with care, it will look after your comfort and aid you in your work for a long time to come

Cramer CHAIRS ARE

GOOD CHAIRS

Scientifically planned to aid YOU in your work . . . designed to support you comfortably whether you're chewing your pencil or bent over hard at work . . . engineered from the quality materials YOU would recommend, with independently adjustable seat, back and footring to conform to your physique . . . and with removable, replaceable covers in a wide range of fabrics and colors to match YOUR decorating plan.

Pictured, Cramer Hi-Model 4D-22T with forward-tilt seat; others available. All are low-gravity balanced for safe use on casters if desired.

LIKE MORE INFORMATION?

Cramer Posture Chair Co., Inc., Dept. E
1205 Charlotte, Kansas City 6, Mo.
Please send me complete facts on the Cramer Hi-Model chairs designed for working architects and engineers.

Name _____

Firm _____

Address _____

of punched mounting holes for component inserters. Permitting punching at temperatures as low as 68 F, the new grade assures precise dimensions of holes and hole spacings. This cold punching laminate is available in the same thickness range, tolerance, and sheet sizes as the company's other XXXP grades. National Vulcanized Vibre Co., Wilmington, Del.

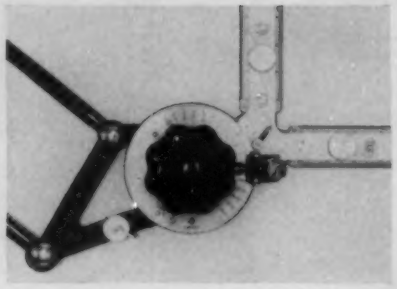
For more information—
Circle 115, inside back cover

Felt Machinery Mounts

Adhesive-coated felt mounts for use under machinery are available in several thicknesses. It may be purchased cut to size or in flat sheets. The mounting is made from wool felt, said to be resistant to oil, grease, acids. Western Felt Works, 4021 Ogden Ave., Chicago 23, Ill.

For more information—
Circle 116, inside back cover

ENGINEERING EQUIPMENT



Drafting Machines

The parallelogram on which this German device is based is made up of oval tubes with selected zero radial play ball bearings at each joint. There are fifteen such ball bearings in the entire instrument. At assembly the machine is inspected to ascertain that no deviation from parallelism at any point over the entire board exceeds 0.6 min of arc (0.00017 in/in). The 15 deg index intervals are also required to be accurate within 0.6 in. min., for acceptance. Both vertical and horizontal board models of this new drafting machine are available, in sizes 32 x 47 in., 39 x 59 in., 49 x 79 in. Evenline Products, P.O. Box 47, East Side Station, Providence 6, R. I.

For more information—
Circle 117, inside back cover

General Purpose Drafting Machine

This Swedish-made instrument is constructed of cold-drawn steel tubing and machined steel and plastic parts. It sets and holds any angle and its complement, combining the functions of T-square, triangle, protractor and scales. The protractor head reads from 90 through 0 to 45 deg, with automatic quick-set lock every 15 deg. The head also locks easily at any desired angle between the 15 deg stops. Walpole Co., 419 Boylston St., Boston 16, Mass.

For more information—
Circle 118, inside back cover

Lamp for Drawing Board Provides 100 ft-c

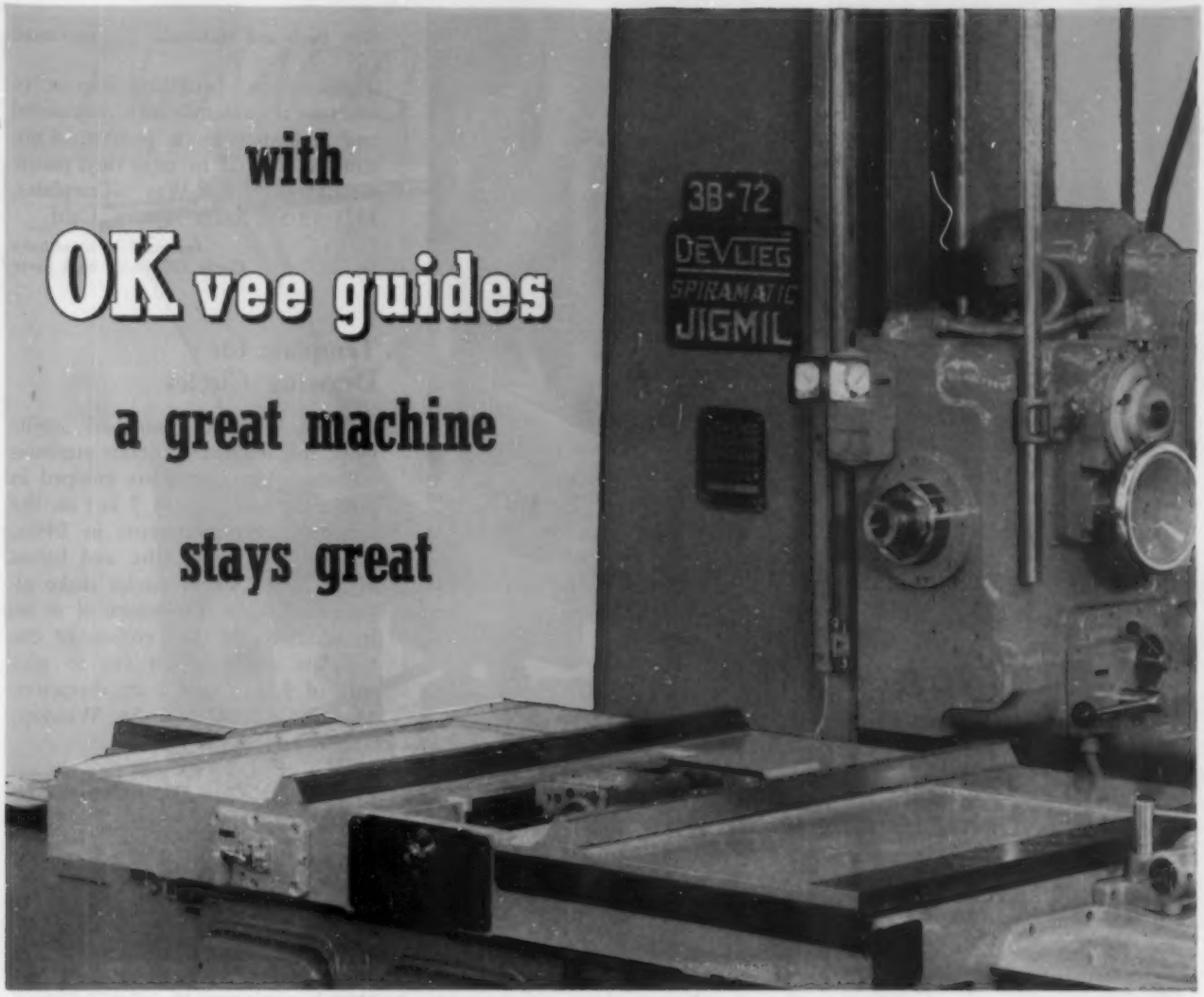
This lamp is said to illuminate the entire working area with 100 ft-c. It is designed for use with two 40-w fluorescent lamps, and is 4 ft long. Adjustable for height, the fixture clamps on the back of any drafting board, large or small. Midwest Lighting Products Co., P. O. Box 536, Cleveland 7, Ohio.

For more information—
Circle 119, inside back cover

Template for Squares and Their Diagonals

Any size square from 0 to 3 in. can be drawn by an adjustment of the slider. Three scales are provided in decimal inches, fractional inches and

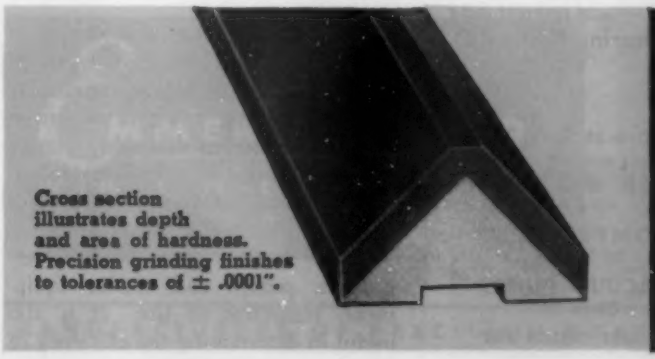
with OK vee guides a great machine stays great



THE DeVLIEG MACHINE CO. has been a consistent user of OK Hardened Products for many years. They build absolute precision into their line of boring and milling machines. One of the methods of achieving this ultra-precision throughout the life of their machines is with OK hardened vee guides as illustrated in this exposed photo of their Spiramatic Jigmil.

Here's why OK hardened vee guides contribute to machine tool accuracy: They are virtually wear-proof, a result of welding special analysis tool steel to a mild steel backing. High wear-resistant properties are produced by special hardening (Rockwell C-65-66) to a depth of 3/16"

For Free bulletin, showing seven standard cross sections in over 60 sizes, write Dept. 45-B



Cross section illustrates depth and area of hardness. Precision grinding finishes to tolerances of ± .0001".

Hardened Ways • Slitter Knives • Shear Blades
Cut-off Blades • Hardened Spacers • Gibs • Ball Races
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THE OHIO KNIFE CO.

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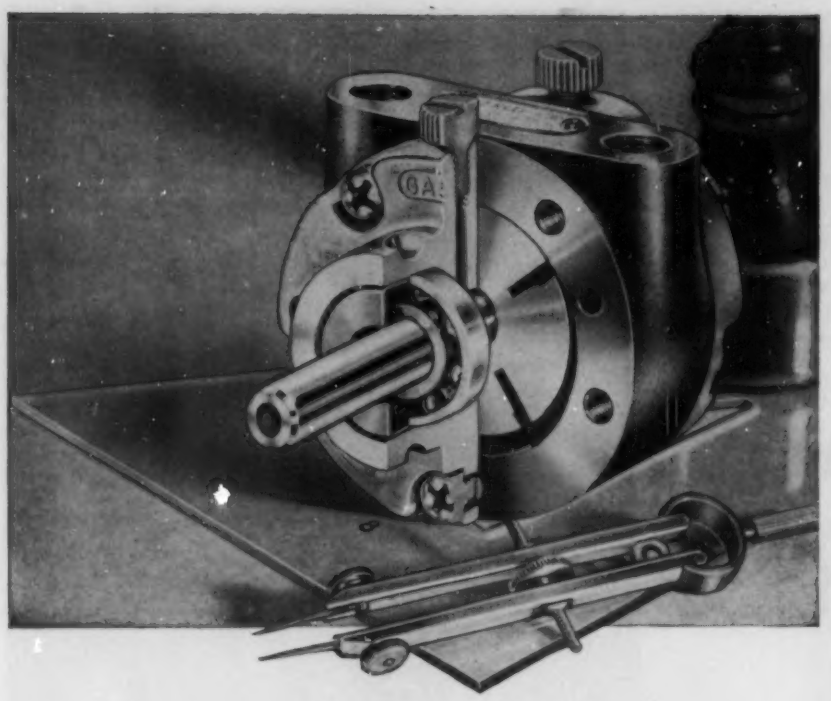
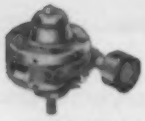


All Gast rotary air motors, compressors, vacuum pumps are designed on this

SIMPLE PRINCIPLE



Rotary Air Motors
1/20 to 4 h.p.

Air Compressors
to 30 p.s.i.
to 24 c.f.m.

Vacuum Pumps
to 28 in.
to 24 c.f.m.

Always striving for simplicity in products you design? So are we. Simplicity pays — in lower costs and greater dependability. And it's a *big* reason why engineers favor Gast components . . . and why users get years of satisfactory service.

All Gast Units incorporate this simple, rotary-vane principle: A rotor and four sliding vanes are the only moving parts. Centrifugal force holds self-seating vanes tightly against the precision-ground interior surface of housing, maintaining a continuous seal, and taking up any wear automatically. Usually of composition material, vanes may be carbon (for oil-less models) or aluminum. Air delivery is positive, pulseless, quiet.

There are *no* piston rings, *no* heavy hinged parts, *no* rockers, etc., to wear out, require adjustment or add dead weight. *No* bulky air tanks, either.

So get the advantages of Gast simplicity for *your* products! *Write for new "Application Ideas" Booklet — and request data on models that interest you.* Gast Manufacturing Corp., P.O. Box 117-V Benton Harbor, Michigan.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

metric system. Length of diagonal of squares is automatically computed and indicated by a pointer. Constructed of 0.020 in. rigid vinyl plastic throughout. E-Z-Way Templates, 1321 19 St., Santa Monica, Calif.

For more information—
Circle 120, inside back cover

Template for Drawing Circles

Made of rigid, non-glare acrylic vinyl, this template contains precision milled circles. Circles are grouped in progressive sizes ($\frac{1}{16}$ to 3 in.) on the template with increments in 64ths, 32nds, 16ths, 8ths, 4ths, and halves of an inch. All 44 circles make allowance for pencil clearance of $\frac{1}{32}$ in. In addition, the four corners of the template are precision cut to give radii of $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 in. diameters. Alvin & Co., 1618 Main St., Windsor, Conn.

For more information—
Circle 121, inside back cover

Transistor Power Supply

A d-c power supply especially engineered to power resistors is a closely regulated, dual-voltage unit, with both outputs contained in a single chassis suitable for rack mounting or bench use. Cabinet size: $5\frac{1}{4}$ x 19 x 14 in. Each output supplies 0 to 100 v, dc, continuously variable (without switching), and 0 to 100 ma, max. Voltage is adjustable to $\frac{1}{10}$ v variations. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.

For more information—
Circle 122, inside back cover

Mechanical Sound Detector

A listening device that makes it possible to detect certain types of internal defects in moving machinery without shutting down or otherwise taking the equipment out of service amplifies normally inaudible defect-caused noises. It allows the user to locate faulty parts in reciprocating engines, motors, gear boxes, compressors, pumps and similar equipment, regardless of size. It is also useful in determining the efficiency of

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EMMERT RIGHT ANGLE DRAFTING UNITS

EMMERT Right Angle Drafting Units bring to the drafting room the ultimate in versatility and efficiency.

These attractive, all-steel units provide the operator with everything needed, instantly available without rising from the chair—adjustable, counterbalanced drawing board . . . reference area . . . tool and storage space.

Versatility in arrangement is provided, too. **EMMERT** Right Angle Units may be assembled in either right or left-hand arrangements. Change-over from right to left may be accomplished quickly and easily, by your own personnel at any time after original installation.

Finished in a rich grey with mist green linoleum tops, these units blend perfectly with any color scheme.

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* **EMMERT** Right Angle Drafting Units are available with or without **EMMERT** Micro-Drafting Instruments as pictured in the illustration above.

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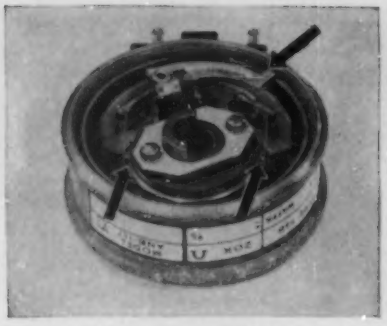

Arrows point to Paliney #7 contacts used in this Fairchild Type 746 Precision Potentiometer.

NEY'S small parts play a BIG part in precision instruments

Reliability of many precision electrical instruments depends upon accurate transmission of electrical signals between moving parts. The Potentiometer Division of the Fairchild Camera and Instrument Corporation has selected Ney Paliney #7* for use as wipers and sliders in their precision potentiometers because Paliney #7 provides the important advantages of a long life with excellent linearity and the ability to hold noise at a minimum.

Ney manufactures many other precious metal alloys which, like Paliney #7, have ideal electrical characteristics, high resistance to tarnish, and are unaffected by most industrial atmospheres. Ney Precious Metal Alloys have been fabricated into slip rings, wipers, brushes, commutator segments, contacts, and intricate component parts and are used in high precision instruments throughout industry. Should you have a contact problem, a call to the Ney Engineering Department will result in study and recommendations which will improve the output of your electrical or electronic instruments.

THE J. M. NEY COMPANY • 109 ELM ST., HARTFORD 1, CONN.

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9NY55B

Ruthman GUSHER coolant pumps

Designed FOR BETTER PERFORMANCE

Ruthman Gusher Coolant Pumps offer you simple yet sturdy design features. There are no friction seals or packing. The Gusher is always primed, gravity insures immediate pump action. Pre-lubricated heavy-duty ball-bearings require no further attention and the dynamically balanced rotating shaft eliminates vibration. Specify Gusher Pumps for better performance.

Illustrated is a HANCHETT Model AK traveling Wheel Head Knife Grinder equipped with a Gusher Pump

THE RUTHMAN MACHINERY CO.

1818 Reading Road Cincinnati, Ohio

steam traps and locating air or liquid leaks in underground piping.

Resembling a doctor's stethoscope in design, the detector utilizes dual detectors to transmit sounds to one or both ears as desired.

A pair of extension rods are furnished with each unit for reaching into remote places. An interchangable bell stethoscope is also supplied to detect pressure or vacuum leaks around head gaskets, manifolds. All metal parts are machined from stainless steel. Hose and ear plugs are made of soft, durable live rubber. Burke & Co., Worton, Md.

For more information— Circle 123, inside back cover

Measures Speed At a Distance

A visual tachometer which measures rotary or vibratory speeds of machinery or objects at a distance of 3 to 50 ft operates by a spring-wound mechanism which stops motion, on a stroboscopic principle. It is a mechanical instrument slightly larger than a baseball and weighs 11 oz.

The new tachometer is made in two basic ranges: 500 to 8000 and 1,000 to 16,000 rpm. It is accurate at any scale point above the first 15 per cent of either scale to within 2 per cent. Boulin Instrument Corp., 65 Madison Ave., New York, N. Y.

For more information— Circle 124, inside back cover

Electronic Flaw Detector

A portable instrument for detecting faults and bearing failures in motors and machinery, leaks in pipelines, and surface flaws in materials has been introduced. These impend-

ing troubles are said to be accompanied usually by an audible warning which, because of frequency, intensity or surrounding noises, may not be heard by the unaided ear.

The new detector weighs 2½ lb. It consists of a highly sensitive contact-microphone encased in a probe handle, a three-stage amplifier and plug-in headphones. Visual measurement can also be obtained by adding an output meter. The unit is powered by standard batteries. John Ould, (USA) Ltd., 519 S. Fifth Ave., Mount Vernon, N. Y.

For more information—Circle 125, inside back cover

Mobile Power Supply

A laboratory power supply transformer unit for on-the-spot availability of any desired output voltage has a three-phase, 230-250 v, 60 cps, a-c input. The unit has two output ranges: 211 to 640 v, 31 amp in 10-v steps, and 100 to 295 v, 66 amp, in 4-v steps. Adjustment is by eight fine steps and eight coarse steps with overlap. Taps are changed on three phases simultaneously. It is designed for continuous duty at the rated output, and includes a heavy duty 115 v cooling fan.

The sheet metal case measures 42 x 13¾ x 29 in. Strong Electric Corp., 98 City Park, Toledo 2, Ohio.

For more information—Circle 126, inside back cover

Digital Voltmeter

Sensitivity of this voltmeter is said to be such that 10 millivolt provides full-scale digital output (999). Controls permit selection of any voltage in either of two ranges (10 to 25 and 20 to 50mv) for full-scale readout. Digital output appears on an illuminated panel for visual readings, and is also available through contact closures representing three decimal digits. Output may be used for operation of automatic typewriters, card punches and tape punches. The instrument requires no external power supply other than 115-v, 60 cps, ac. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

For more information—Circle 127, inside back cover

Need brakes for THRU-SHAFT motors?
All DINGS Direct Acting Magnetic Brakes are available for THRU-SHAFT installation
OUTSTANDING FEATURES . . .
✻ SIMPLICITY—rugged, compact construction; easily accessible; simple to install and adjust—and NO mechanical linkages to require maintenance. Simple, fast release.
✻ INSTANT DIRECT-ACTING OPERATION—movement of braking assembly measured in thousands of an inch. Braking or releasing is therefore virtually instantaneous.
✻ VERSATILE MOUNTING—Brake "C" flanges mount on old and new NEMA frame sizes. May also be foot mounted.
✻ WIDE TORQUE RANGE—1½ to 175 lbs. ft. Drip-proof and water-proof dust-tight enclosures.
One of the "plus" features of the new Dings Direct Acting Magnetic Disc Brake is the fact that standard NEMA length shaft extensions may be used, eliminating the need for special shaft extensions to accommodate motor mounted brakes. A simple modification of the brake cover converts Dings Brakes for "THRU-SHAFT" applications. This facilitates direct coupling or use of hand cranks, electrical tachometers, pulleys, plugging switch, etc.
Dings Direct Acting Magnetic Disc Brakes can be installed anywhere a shoe brake is used and in addition can be installed where a shoe brake is not suitable because of appearance and space considerations.
Be sure to specify Dings Magnetic Brakes to meet your needs, from your regular motor supplier. While these efficient units are easy to select and apply, Dings offers complete engineering service to help solve your specific brake problems. Write for Bulletin BK4002.
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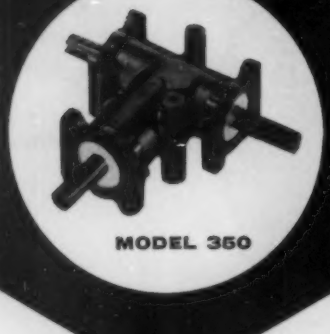
See our Catalog in SWEETS PRODUCT DESIGN FILE--Section 5a/Di.
D8355½

ANGLgear Horsepower UP...



...but price stays down!

3 hp at 1200 rpm! That's the new rating of the rugged 2 and 3-way ANGLgear models shown above. And — we repeat — there is no change in purchase price.

The expanding ANGLgear line — now including 1/3, 1 and 3 hp units available with 1-1 or 2-1 gear ratio and with either 2 or 3-shaft extensions — enjoys wide acceptance in many fields. It's sold only through your local distributor. See our literature in the product design section of Sweet's Catalog.

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HILLSIDE 5, NEW JERSEY

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Stainless Tubing and Tubular Parts—Catalog, 8 pp, describes cold drawn mechanical, capillary and hypodermic tubing from 0.008 to 1.000 in. OD; nickel and nickel alloy tubing and tubular fabricated parts. Data is given on comparative analysis of alloy types, specifications, standard tolerances and physical properties and relative workability. J. Bishop & Co., Malvern, Pa.
Circle 128, inside back cover

Wire Rope Assemblies—Catalog TL-500, 24 pp, shows possible combinations of standard fittings and assemblies, and also includes necessary reference charts, tables, drawings. Among fittings illustrated are yokes, sleeves, eyes, hooks, buttons, balls. American Chain & Cable Co., Inc., Wilkes-Barre, Pa.
Circle 129, inside back cover

Speed Control Packages—Bulletin 51-B8166, 8 pp, describes package drives for speed control of machine tools and other equipment requiring accurately variable speed over a wide range. The drive, available in five cabinet sizes with drive motor range 5 to 150 hp, features magnetic amplifier generator field control. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.
Circle 130, inside back cover

Vacuum Melted Alloys—Booklet, 8 pp, describes vacuum melting process and characteristics of resulting alloys. Utica Drop Forge & Tool Corp., Utica 4, N. Y.
Circle 131, inside back cover

Epoxy Adhesive—Bulletin 2501, 2 pp, provides details on surface preparation, application, assembly of parts to be bonded and characteristics of the adhesive. Houghton Laboratories, Inc., Olean, N. Y.
Circle 132, inside back cover

Lithium Industrial Greases—Bulletin, 2 pp, details specifications of multipurpose lithium soap greases. Sinclair Refining Co., 600 Fifth Ave., New York, N. Y.
Circle 133, inside back cover

Magnesia-Insulated Conductors—Bulletin, 2 pp, describes why, where and how wires insulated in this manner are used. A table of specifications is also provided. Aero Research Instrument Co., 1040 Grand Ave., Chicago 22, Ill.
Circle 134, inside back cover

General Purpose Power Supply—Bulletin 178, 2 pp, covers unfiltered units rated from 5 to 150 and from 6 to 230 v, dc. Opad Electric Co., 69 Murray St., New York 7, N. Y.
Circle 135, inside back cover

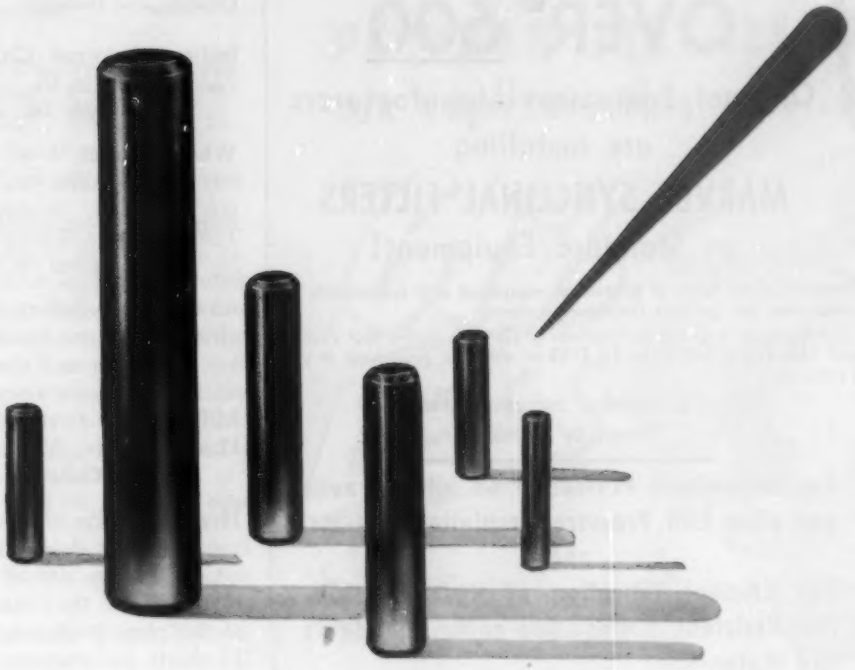
Totally Enclosed, Explosionproof Motors—Bulletin, 4 pp, contains colored cross-section of the motor, with call-outs pointing out construction details. Photographs and drawings illustrate stator core, asbestos-protected windings, lubrication systems. U. S. Electrical Motors, Inc., Box 2058, Los Angeles 54, Calif.
Circle 136, inside back cover

Magnetic Disc Brakes—Bulletin BK 4002, 8 pp, describes brakes having torque ratings from 1¼ through 175 lb-ft. Dings Brakes, Inc., 4740 W. Electric Ave., Milwaukee, Wis.
Circle 137, inside back cover

Brazing Preforms—Catalog, 12 pp, describes silver alloy preforms for brazing applications. Available alloys, forms and shapes, wire sizes, ordering helps are included. Lucas Milhaupt Engineering Co., 5051 S. Lake Drive, Cudahy, Wis.
Circle 138, inside back cover

Posture Chairs—Catalog, 8 pp with price list, illustrates and describes chairs for office, drafting room and other locations. Cramer Posture Chair Co., 1205 Charlotte, Kansas City 6, Mo.
Circle 139, inside back cover

Photoelectric Controls—Catalog 55, 15 pp, shows photoelectric controls ranging from moderate sensitivity to ultra-sensitive, high speed and impulse actuated units. Available with safety relays and with warm-up pro-



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It retards corrosion and rusting
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With H-K Dowel Pins, driving is easier
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This figure represents manufacturers of all types of production equipment and components of equipment utilizing hydraulic and other low pressure circulating systems.

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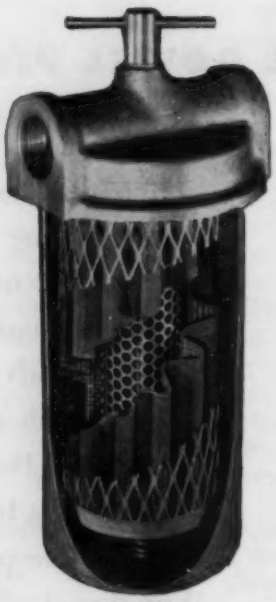

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Both sump and line types may be easily disassembled, thoroughly cleaned and reassembled by any workman, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

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- ☐ Data on filters for Fire-resistant hydraulic fluids.

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Company _____

Address _____

City _____

State _____

tection. Autotron Co., P. O. Box 722-V, Danville, Ill.

Circle 140, inside back cover

Wheels—Folder, 4 pp, describes various types of rubber tire wheels, diameters to 18 in. Rotary Mfg. Corp., 1205 Charlotte, Kansas City 6, Mo.

Circle 141, inside back cover

Air Cylinders—Bulletin A-105K, 8 pp, gives design, construction, engineering, mounting and dimensional data on 200 psi heavy duty air cylinders. Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle 142, inside back cover

Heat Absorption of Steel—Booklet, 32 pp, details a simplified method by which heating rate of steel can be calculated and the center temperature of the piece predicted. Included are 15 charts and diagrams. Bloom Engineering Co., Inc., 857 W. North Ave., Pittsburgh 33, Pa.

Circle 143, inside back cover

Hot-Formed Nuts—Bulletin, 4 pp, includes a table of mechanical properties and a comparison of physical properties with cold-formed nuts. Pittsburgh Screw and Bolt Corp., Pittsburgh 30, Pa.

Circle 144, inside back cover

Constant-Force Springs—Bulletin 310-L-6-55, 24 pp, contains detailed instructions for extension spring design including material selection, estimation of fatigue life, load and dimensional requirements, and final selection and identification. Fourteen design charts based on selected materials and fatigue life requirements are included. Hunter Springs Co., Lansdale, Pa.

Circle 145, inside back cover

Specialty Steels—Booklet, 32 pp, defines the distinctive characteristics of a broad range of special purpose steels in terms of end use. It briefly summarizes specialty product line, covering tool and die steels; stainless steels; silicon and high nickel electrical alloys; special purpose alloy steels; valve, heat-resisting and super alloy steels, tubing and pipe in various analyses and fine wire specialties. Carpenter Steel Co., 317 W. Bern St., Reading, Pa.

Circle 146, inside back cover

Electrical Switches—Catalog 655, 24 pp, describes high-sensitivity, metal-cased, immersion-proof, general-pur-

pose, AN-type, JAN-type, d-c and subminiature switches. Unimax Div., W. L. Maxson Corp., 460 W. 34 St., New York 1, New York.

Circle 147, inside back cover

Pneumatic Equipment—House Organ, 7 pp. First issue to be published, bimonthly, contains application stories with engineering drawings, discussion of fundamentals of pneumatics in the first of a series of primer stories. A digest of current trade journal articles on pneumatics is included. Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 148, inside back cover

Solenoid Brakes—Bulletin EE 180, 3 pp, describes brakes with continuous duty ratings of 3 to 24,000 ft. lb. Trombetta Solenoid Corp., Milwaukee, Wis.

Circle 149, inside back cover

Enclosed Switches—Catalog 83, 28 pp, describes switches designed for use on either a-c or d-c applications. Included are general purpose switches, sealed switches, heavy-duty limit switches, hand-operated switches and maintained contact switches. Micro Switch, Freeport, Ill.

Circle 150, inside back cover

Hydraulic Cylinders—Bulletin, 8 pp, describes cylinders for lift, tilt, lower, eject, reciprocate, swing, turn, clamp, hold and squeeze action. Benton Harbor Engineering Works, Inc., Benton Harbor, Mich.

Circle 151, inside back cover

Filter-Lubricators—Catalog, 16 pp, has listings of sizes and types of air filters and lubricators produced. Installation and maintenance are covered in detail and a dimension sheet and parts list are included. Master Pneumatic, Inc., 20432 Sherwood, Detroit 34, Mich.

Circle 152, inside back cover

Oil-Hydraulic Pumps, Controls—Catalog 5001A, 56 pp, describes line of pumps, controls and accessories for general industrial application. Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.

Circle 153, inside back cover

Speed-Sensitive Switches, Governors—Bulletin 5045, 8 pp, includes dimensional drawings of overspeed, underspeed, one, two and three-switch governors with explanations of the vari-

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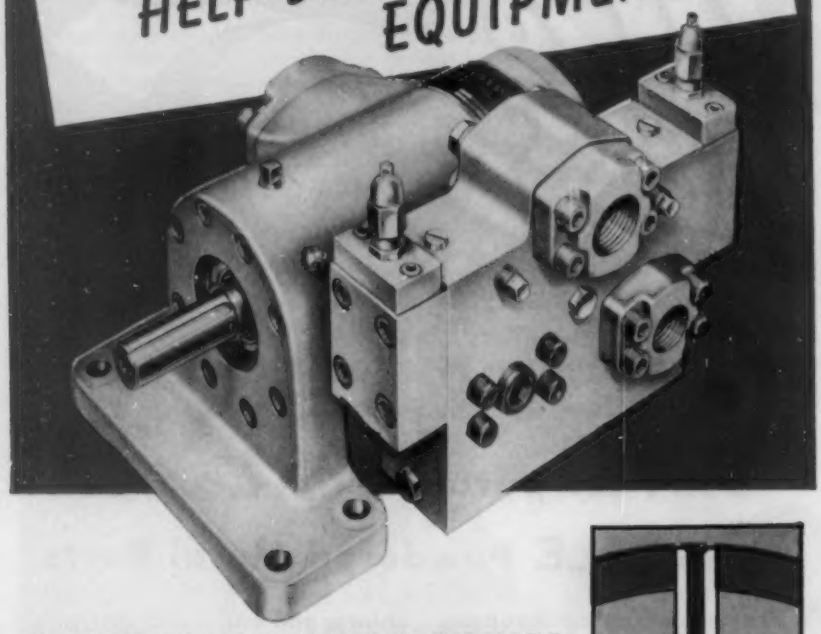
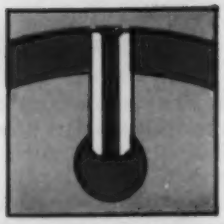
HELP SELL YOUR EQUIPMENT!





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DUDCO Pumps can operate *continuously* at 2000 psi. Their exclusive "Dual-Vane" feature and advanced design combine to assure long, trouble-free performance and maximum simplicity in servicing. Thus, they are a natural choice for a wide variety of high production equipment, including: Machine Tools, Hydraulic Presses, Die Casting and Plastic Moulding Machines, Closing and Clamping Devices and other functions calling for controlled variation in Pump volume.

The PLUS factors in DUDCO Pumps weigh heavily at the sales end—so, WRITE...get the facts on DUDCO Dual-Vane Hydraulic Pumps and Fluid Motors.

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.

ous types of take-off and connectors. Synchro-Start Products, Inc., 8151 N. Ridgeway Ave., Skokie, Ill.

Circle 154, inside back cover

Air Cylinders and Devices—Catalog, 53 pp, describes pneumatic cylinders and air-operated equipment. Mead Specialties Co., Inc., 4114 N. Knox Ave., Chicago 41, Ill.

Circle 155, inside back cover

Metal Spinning—Data Book 3, 38 pp, describes process, equipment, applicability, materials, design recommendations. Spincraft, Inc., 4122 W. State St., Milwaukee 8, Wis.

Circle 156, inside back cover

Pressure Generators—Bulletin 755, 4 pp, describes pressure generators designed to produce hydrostatic pressures as much as 500 times greater than normal plant air supplies. Information includes overall capacity pressure ranges, theory of operation and application details. Milton Roy Co., Station J, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle 157, inside back cover

Tool Steels—Booklet, 44 pp, entitled "Tool Steels for the Non-Metallurgist," is written to present a practical understanding of tool steels without being overly technical. Discusses six basic classifications of tool steels. Crucible Steel Co. of America, P. O. Box 88, Pittsburgh 30, Pa.

Circle 158, inside back cover

General Purpose D-c Power Supply—Bulletin 178, 2 pp. Twenty-two standard models are covered with unfiltered outputs ranging from 6 to 230 v, dc, and 0.6 to 150 amp. Opad Electric Co., 69 Murray St., New York 7, New York.

Circle 159, inside back cover

Silicone Rubber—Folder, 4 pp, details properties and performance as affected by extreme temperatures, weathering, compression, chemicals and dielectric service. Dow Corning Corp., Midland, Mich.

Circle 160, inside back cover

Industrial Fibers—Bulletin F-120-2, 4 pp, describes fibers produced from redwood and redwood bark used in large commercial quantities for such varied applications as filtering agents, ceramic burnout fillers, thermal insulation, reinforcing in molded products, furni-

ture and toy stuffing, textile blends, special papers, packaging and bulk filling, concrete filler, sealing porous formations in oil well drilling. Pacific Lumber Co., 100 Bush St., San Francisco 4, Calif.

Circle 161, inside back cover

Arc-Cast Molybdenum—Booklet, 72 pp. A compilation of all available technical and fabricating data on arc-cast molybdenum. Climax Molybdenum Co., 500 Fifth Ave., New York 36, N. Y.

Circle 162, inside back cover

Ball Bearing Sprocket Idler—Bulletin, 4 pp, describes idler that has prelubricated, sealed bearing. Aetna Ball & Roller Bearing Co., 4600 Schubert Ave., Chicago 39, Ill.

Circle 163, inside back cover

Shaped Tubing—Data sheets 17, 3 pp, gives information on analyses available (stainless, carbon, nickel and nickel alloys, glass sealing alloys, titanium, and beryllium copper), tool charges, size range, commercial tolerances, lengths, temper. Superior Tube Co., 1556 Germantown Ave., Norristown, Pa.

Circle 164, inside back cover

Chromium Plating—Bulletin CFC-1, 4 pp, is illustrated with comparative cross-sectional and surface views of crack-free chromium and ordinary chromium plating together with photos of applications. United Chromium, Inc., 100 E. 42 St., New York 17, N. Y.

Circle 165, inside back cover

Ball Screws—Brochure, 4 pp, gives load capacities, design standards, design considerations, typical nut adaptors. Beaver Precision Products, Inc., Clawson, Mich.

Circle 166, inside back cover

Cold Forming—Data sheets. These are first two of a series of design information publications giving basic data about the fundamental principles and advantages of the cold-forming process of producing small parts and fastenings. Townsend Co., New Brighton, Pa.

Circle 167, inside back cover

Plug-in Components—Catalog 827, 36 pp, presents circuit drawings and specifications on 36 different plug-in units. A number of typical applica-

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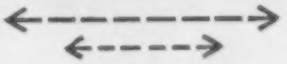

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Or, when the function involves motion in more than one direction, custom design develops mountings to suit the application...

Or cylinder movement in any direction, and many other variables are yours with HYDRECO Custom Design.

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tions are also presented. Eeco Production Co., 506 E. First St., Santa Ana, Calif.

Circle 168, inside back cover

Bellows and Metal Hose—Catalog 150, 16 pp, has specifications on flexible metal hose through 14 in. ID. Flexonics Corp., 1351 S. Third Ave., Maywood, Ill.

Circle 169, inside back cover

Miniature Bearings—Catalog, 1955-56 edition, 22 pp, describes over 500 standard radial ball bearings, tabulated by bore size (ranging from 0.0250 to 0.2500 in.). Sixteen types of radial bearings are analyzed in detail, including two new series of bearings. Miniature Precision Bearings, Inc., Keene, N. H.

Circle 170, inside back cover

Aluminum Alloys—Slide rule shows common designation, applicable specifications, physical and mechanical properties for all major aluminum casting alloys for sand and permanent mold castings; for heat-treatable alloys, properties are shown for each condition. Relative properties are given for corrosion resistance, machinability and suitability for welding.

Circle 171, inside back cover

Heat Transfer Equipment—Bulletin 850, 4 pp, contains engineering data and general application information on a heat-transferring surface configuration. Bush Mfg. Co., W. Hartford, Conn.

Circle 172, inside back cover

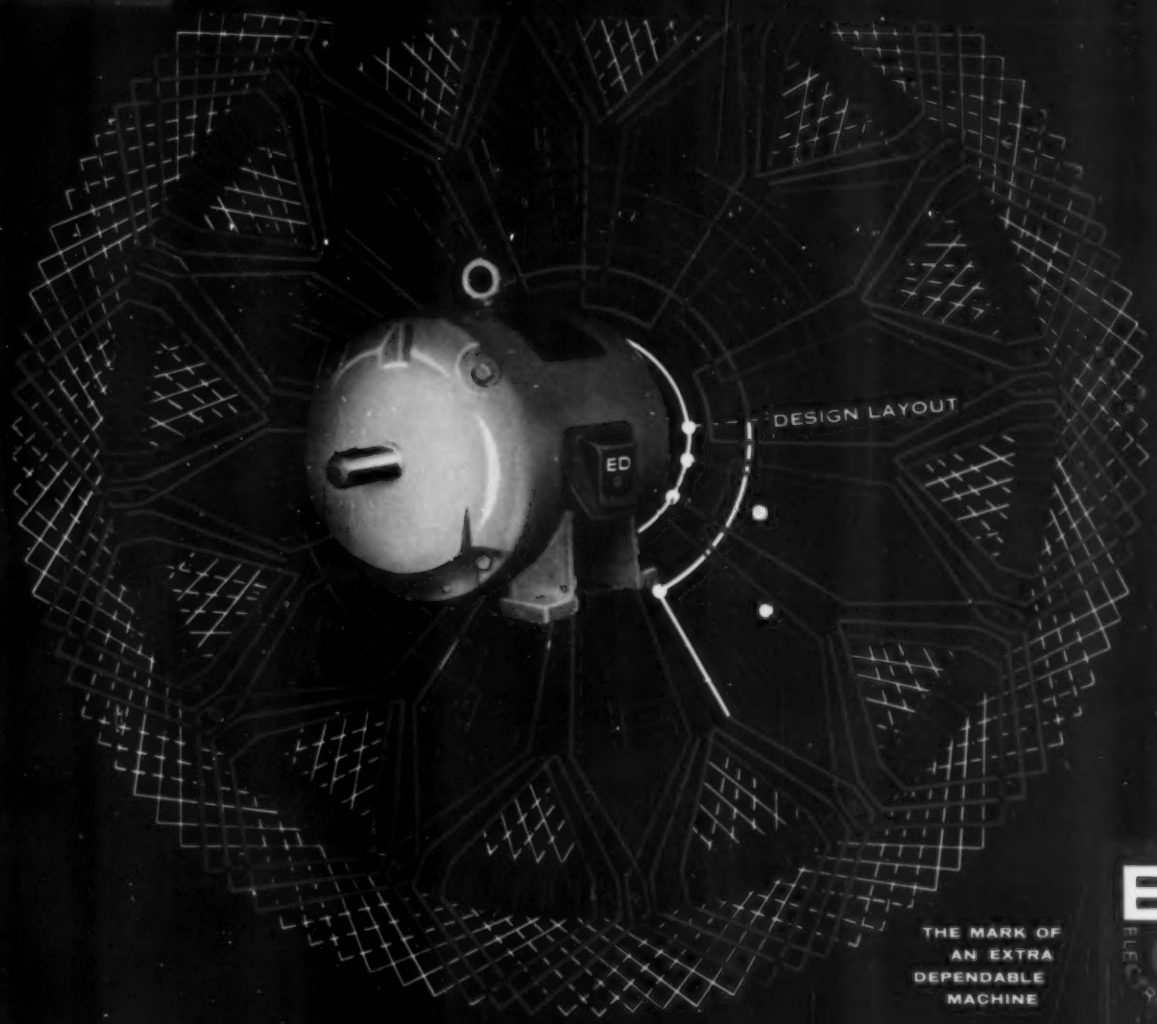
High Stability Resistors—Bulletin, 2 pp, contains information on matched networks, tolerances, temperature and voltage limits. Pyrofilm Resistor Co., 8 Whippany St., Morristown, N. J.

Circle 173, inside back cover

Sequence Valves—Data sheet, 4 pp, describes and illustrates valves for 3000 psi hydraulic service, with standard maximum internal leakage of 15 drops per minute. Aircraft Products Co., 300 Church Road, Bridgeport, Pa.

Circle 174, inside back cover

Stainless Steel—Technical study 5, 10 pp, gives technical information on AM 350, the stainless steel that bridges the gap between the 300 and 400 series. Tables on mechanical properties, stress rupture properties, elevated temperature tensile properties, corrosion rates in various media, and effects



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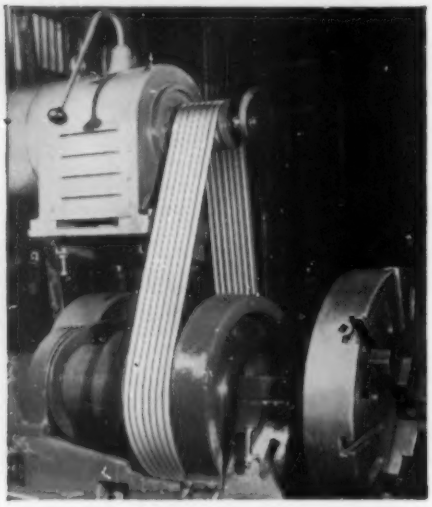
This large lathe was formerly driven by a flat belt which slipped on heavy cuts, stalled and broke tool bits. Savings on broken tool bits alone offset the cost of the drive the first year—and production was increased 25% after the V-belt drive was installed.



concave sides lengthen V-belt life ...cut costs

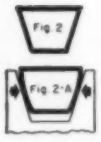
Hundreds of plants that keep track of V-belt drive costs know this: Gates Vulco Ropes . . . the V-belts with *concave sides*...wear much longer and *cost less per year of service.*

Here is the interesting reason why:

When a Gates V-belt bends around the sheave, the *precisely-engineered* concave sides (Fig. 1) fill out and become straight. Thus the sides of the belt make full, uniform contact with the pulley (Fig 1-A).

Naturally, uniform contact distributes the wear *evenly*. And *even* wear means *longer* wear.

Longer wear saves not only on replacement costs; it also saves the cost of down-time... keeps equipment producing.



Simple test proves value of concave sides

Take a straight-sided V-belt (Fig. 2) and bend it. Feel the sidewalls of the belt bulge out as the belt bends. You see immediately that the bulging sides prevent uniform contact with the pulley (Fig. 2-A). Uneven contact causes faster wear...increases your drive replacement costs.

Let the cost-saving longer life of Gates Vulco Ropes contribute to *your* profits. Specify Gates Vulco Ropes—the V-belts with concave sides (U.S. Patent 1813698). The Gates Rubber Co., Denver, Colorado—*World's Largest Maker of V-belts.*

Gates Engineering Offices and Distributor Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA-54A

GATES VULCO ROPE DRIVES

of cold rolling and aging on hardness and tensile properties are included. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa.

Circle 175, inside back cover

Electric Counters–Bulletin ECS 44, 4 pp, describes counters designed for 200 million count life, tested at 1000 counts per min. Production Instrument Co., 702-10 W. Jackson Blvd., Chicago 6, Ill.

Circle 176, inside back cover

Stepping Switches and Relays–Circular 1843, 4 pp, describes line of control components for industrial use, including stepping switches, relays and key switches. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle 177, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Quick-Disconnect Coupling–Bulletin 230, 4 pp, describes coupling's uses and construction. Snap-Tite, Inc., Union City, Pa.

Germanium Power Rectifiers–Bulletin GPR-1, 4 pp, lists ratings and specifications. Also included are operating instructions and typical dynamic characteristic curves for two rectifier styles. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Power Supply–Bulletin M60VMC, 2 pp, describes 0 to 32 v, 25 amp magnetic amplifier tubeless regulated d-c power supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Power Supply–Bulletin MR2432-100X, 2 pp, describes what is claimed to be smallest 28 v, 100 amp regulated and filtered power supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Scientific and Engineering Data–Booklet, 112 pp, contains selected chemical and physical, engineering, plastics, bacteriological, leather, psychometric and textile tables and charts. United States Testing Co., 1415 Park Ave., Hoboken, N. J.

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

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Please send me fastener catalogs checked:
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I'm not a wise guy, but I do know about the service these Garrett plants give you. Seems hard to believe. Those fellows bend over backwards to help you out in an emergency. And their regular service means you always get deliveries when promised ... sometimes before.

Of course, when it comes to quality they are tops on lock washers, flat washers, spring washers, hose clamps, stampings and assemblies. They have three plants equipped with the most modern high-speed automatic machinery to turn out billions of parts to exact specification . . . complete heat treating, plating and finishing facilities. If you don't believe me, next time send your order into Garrett. You'll see why their customers say YOU CAN'T BEAT GARRETT.

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Ad Libbing by the Editor

Many years ago I heard Charles M. Schwab, then president of Bethlehem Steel Corporation, give a talk to a class of graduating engineers. Charles M. Schwab was a great salesman and an even greater builder of men. He also had much foresight. To this day many of the outstanding qualities of the Bethlehem Steel Company can be traced to Charles M. Schwab. This is not hard to prove. Charles M. Schwab made Eugene Grace president, so there you have it.

When Charles M. Schwab opened his speech to the graduating class he revealed, unconsciously perhaps, the biggest single reason for his outstanding ability as an administrator and builder of men. This is the story he told.

The day after he was promoted from foreman, age about 30, to general superintendent of Bethlehem Steel he thought it would be smart for him to take a walk around the plant, and see how everything was going. So he did that and was passing through the foundry when he saw a shop laborer sitting on the handle of a loaded wheelbarrow and smoking a pipe.

"Ah!" said Mr. Schwab in telling the story. "Here was some genuine loafing on the job. This I should correct immediately and do so in no uncertain terms. So I shouted at the man in a rather bossy fashion, 'What are you doing there?' The man replied, 'I'm smoking my pipe.'

"Obviously the man didn't realize that he was talking to the plant superintendent. Otherwise he wouldn't have been so fresh in his attitude. So my next question was, 'What is your job around here?' to which the man insolently replied, 'What's your job?'

"Now I was certain that the man did not realize that I was the new general superintendent. It was up to me to tell him, and he had given me a good opening to put across that idea in no uncertain words. So I said to him, 'I will have you understand that I am the new general superintendent of this plant.' Again, with his pipe still in his mouth the laborer insolently looked at me and said, 'Mister, you have a good job. You better take care of it.'"

Then Mr. Schwab went on to explain that the man had taught him a number of fine lessons. In the first place, he, Mr. Schwab, was not the man's boss and therefore had no business berating him. Secondly, in his tone and manner of berating the laborer he clearly indicated that he assumed the man was guilty and thereby he made himself very obnoxious. And finally, Charles M. Schwab was truly indebted to the man for having had the courage to teach him the finest lesson he had ever received in business leadership and administration.

Throughout all of his life Charles M. Schwab was known as a man of great humility and a man for whom it was a privilege to work. His immediate subordinates, including Eugene Grace and many others who also be-

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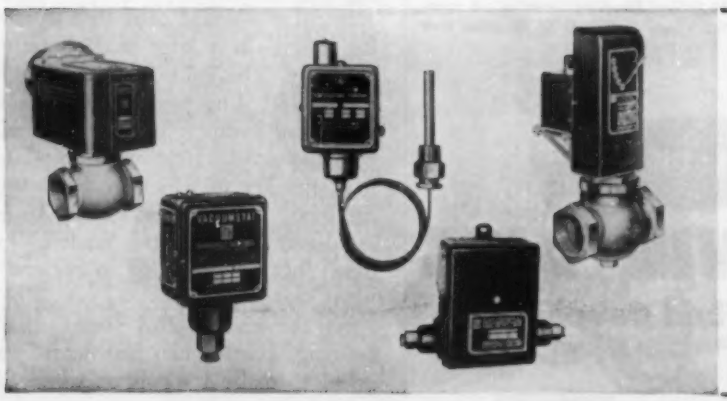

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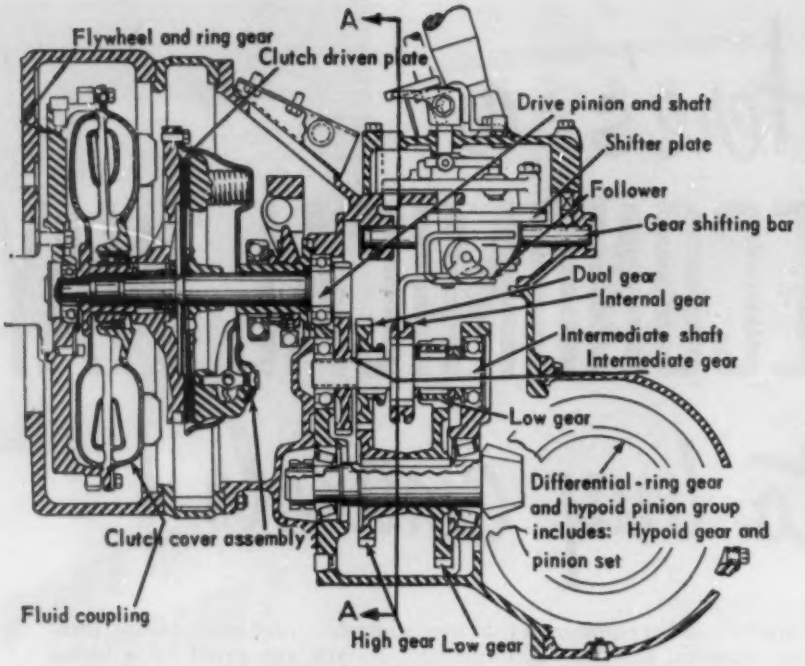


Flywheel redesign conserves space for fluid coupling...

Twin Disc's Fluid Coupling, *mounted compactly within the flywheel,* solved the space problem, reduced clutch maintenance and increased maneuverability of Yale's new G-52 Gasoline Fork Truck.

Materials handling trucks must make many rapid reversals of direction, numerous short runs at high acceleration, smooth starts and stops that won't cause load shifting . . . obviously a fluid coupling job. But, in an already tight arrangement, nesting the coupling *inside the flywheel* was the only solution without increasing truck length.

Next time *you're* planning or designing equipment that requires the power-smoothing, shock-absorbing advantages of Twin Disc Fluid Couplings... particularly where overall space and weight limitations present tough obstacles . . . contact Twin Disc Clutch Company, Hydraulic Division, Rockford, Illinois.

Twin Disc 12.2 Fluid Coupling smooths out operations on Yale's new G-52 line of Gasoline Fork Lift Trucks.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Fluid Couplings

came great in their own rights, not only respected Charles M. Schwab but truly loved the man. The devotion of these men to Charles M. Schwab was clearly demonstrated by them on a number of occasions.

There are many kinds of business leaders. The directing heads of our great corporations range all the way from dictatorial bigots to rather weak "yes" men whose only claim to their position is found in their family tree.

For many reasons, the day that the head of a business organization can be overbearing is vanishing. The strongest companies are those headed by men of character and great human understanding. Even though such a person may lack certain important business abilities, whatever his deficiencies might be they will be more than compensated by the loyalty and devotion of the executives immediately under him. They will take care of anything for the boss who has earned their respect and devotion.

It was said of Andrew Carnegie that it was not his ability as a steel maker but rather his ability to pick the right men, one of whom was Charles M. Schwab, that made Carnegie a great success. But obviously Mr. Carnegie would not have been able to have commanded the respect and devotion of Charles M. Schwab and many others like him if he had not earned it. And the same goes for Schwab and his lieutenants.

When it comes to picking men there is always the problem of putting the right peg in the right hole and, ironically, only too frequently the pegs themselves don't know whether they are round or square.

There was a young man who had a most delightful personality, was well educated, particularly in the liberal arts, and who was bright, hard working and ambitious. More or less by accident this young man took a training course in a large manufacturing company. This led him to spend quite a good deal of his time in the machine shops and assembly departments. He was fascinated. Here was something new, the like of which he had never dreamed. He became intensely interested and then and there made up his mind that he was going to become a plant manager.

At the end of this young man's training course his instructor was asked to make a report and give his

recommendations as to the division of the company in which this man should be given a permanent job. Although the instructor was well aware of the ambitions of this young man he painstakingly explained why the young man, who was highly qualified by personality as a salesman, would find it extremely difficult to master the job of plant manager under any circumstances.

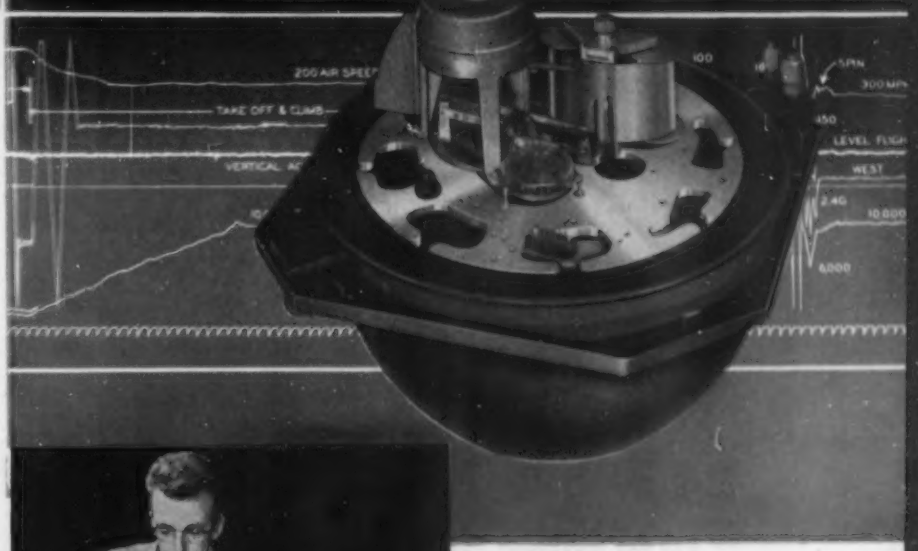
As so often happens, the young man learned about his instructor's recommendations and became incensed. Here was this instructor ruining his whole career. This is merely indicative of the degree to which this fellow had set his mind on becoming a plant manager. But he stayed with the company anyhow. Today he is assistant to the vice president in charge of sales, a well paying lucrative position. He is glad he was forced into the sales department. Had he succeeded in getting placed in the manufacturing end it is doubtful whether he would have gone beyond the position of superintendent of one of the shops.

Many young men utterly fail to distinguish between those things that they like to do and those things they are best qualified to do. It is hard to distinguish between desires and abilities. Often we strongly cherish the desire to do well that which we can by our own limitations do only in a mediocre fashion. Also, it is a common tendency for a person to undervalue those abilities in which he excels. That is why so many men fail to recognize until late in life, or too late in life, that they have wasted their energies on a career for which they were poorly equipped, while at the same time they ignored the careers in which they probably would have excelled.

This leads to the age old question, "How will I ever discover what it is that I can do better than anything else?" The answer is: Work or play all the time and with all energy and enthusiasm! There is always one thing that any given person can do exceptionally well, but it cannot be discovered until that person has tried his hand at it. Hence the importance of working hard, playing hard and continually venturing into new fields. Fortunate is the man whose play becomes his work and whose work is thereby always play. –G.F.N.

Spincraft did it for General Mills

Spincraft can do it for you!



15 Different Operations —

The sphere, protecting the delicate sensing instruments, is completely fabricated by Spincraft. The sphere consists of an outer steel and inner aluminum shell separated by insulating material. The two hemispheres are joined together by an ingenious locking and sealing arrangement. Spincraft's complete fabricating responsibility involved spinning, machining, arc-welding, spot welding, brazing, grinding, sawing, drilling, braking, stamping, phosphate plating, anodizing, painting, assembly and pressure testing. Craftsman (above) is shown assembling a Flight Recorder.

Spun spheres protect mechanical fingers of world's toughest recorder

another example of Spincraft's "start-to-finish" fabrication

This aircraft Flight Recorder, manufactured by the Mechanical Division of General Mills, etches a continuous 300-hour record of heading, air speed, vertical acceleration and altitude on aluminum foil. Each Recorder is fully-enclosed and protected in a specially fabricated sphere — made by Spincraft. The recording device, when enclosed in the sphere, is designed to withstand shocks of 100G's and resist temperatures of 2000°F up to 30 minutes.

This is another example of Spincraft's versatility and manufacturing skill. We offer complete facilities for contract manufacture of finished parts, assemblies and complete products.

Take advantage of our modern tools for spinning, deep drawing and stamping as well as complete fabrication. They can pay off in savings for you.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

WORKSHOP OF AMERICAN INDUSTRY SINCE 1919

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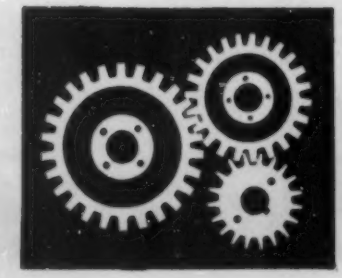
From huge aircraft engines to tiny precision instruments—there's no end to the variety of products improved by Perkins custom-cut Gears!

Perkins is a *gear engineering* organization with a 35 years' tradition of New England craftsmanship as background. As one of the country's largest producers of gears to customers specifications, Perkins will meet your specific requirements for gears—regardless of size, type, material or quantity desired, *and at competitive prices*. You furnish the specifications, we'll produce the gears.

PERKINS MAKES in all materials, metallic or non-metallic, and in any size, to your specifications: helical gears, bevel gears, sprockets, ratchets, worm gears, spur gears with shaved or ground teeth, ground thread worms.

NOTE: The **PERKINS PRECISION SPRING COILER** is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want *when* you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire Sizes .005 to .125. Diameter from 3/32" to 12" and larger. Size of the compact coiler is only 7½ x 16". **A POWER MODEL** mounted on a welded steel console cabinet base is also available. Full information on request.



Perkins Machine & Gear Company

105 Circuit Avenue
West Springfield, Mass.

ABSTRACTS

A Low Inrush Control

Abstracted from "A Low Inrush Control for Large Machine Tool Motors", by Kendall H. Spencer, EE, Blanchard Machine Co., Cambridge, Mass.; presented at the 19th Annual Machine Tool Electrification Forum, sponsored by Westinghouse Electric Corp., April 19 and 20, 1955, Buffalo, N. Y.

There are potential cost-savings in the use of wye-delta motor control for machine tools produced in quantity. The No. 18 vertical surface grinder is an example of a vertical spindle, rotary-table grinder. The work is loaded on a 36-inch dia magnetic chuck, and is ground by the end of a hollow cylindrical grinding wheel about 20 in. dia. The machine is direct motor drive throughout, the motors being started and stopped to control the motions they drive. The wheel motor, which uses wye-delta control, is either 25 or 35 hp., 720 rpm. In addition, there are four small motors: two traverse motors, chuck drive motor, and the coolant pump motor. Many of these machines were sold to small shops. In most such cases, local power companies limited the maximum increment of power that could be connected in a given time; a few restricted the maximum instantaneous current demand.

Starting with the basic requirements of current limitation the various methods of obtaining reduced-current starting were examined. Primary resistance and autotransformer were eliminated because of required enclosure size. Part-winding starting was rejected because it exceeded maximum current limitations. Wye-delta control was not in common usage in this country but seemed to be the most desirable.

With this type of control, the phase current is divided between two starter poles. Four starters instead of three are required, but the starters can be one size smaller than formerly and at a lower total cost. One cost increase results from the necessity for having twelve leads on dual-voltage motors instead of the usual nine. This normally costs 5 per cent of the motor price. Worthwhile savings are found in standardizing machine wiring so that pre-cut

conduit and uniform wiring procedure can be used. Other changes, such as the number and size of wires and cables, show a cost reduction leaving a net saving of about $200 per machine.

In operation on the No. 18 Grinder the maximum current demand is only 33 per cent of what it would be on line-start, or about two times full-load current. Starting torque is about 33 per cent of locked-rotor torque but adequate for the job. Starting is very quiet since the motor is in electrical balance.

There are applications where wye-delta control cannot be used, such as with two-phase machines and three-phase machines using 220/380 v motors. Also starting torque requirements may be too high.

Synthetic Elastomeric Materials

Abstracted from "New and Improved Synthetic Elastomeric Materials for Automotive Use," by W. J. Simpson, Rubber & Plastics Lab., Chrysler Corp., Detroit, Mich.; presented at the SAE Golden Anniversary Passenger Car, Body & Materials Meeting, Sheraton-Cadillac Hotel, March 1-3, 1955, Detroit, Mich.

Buna S or GR-S synthetic rubber manufactured by the Federal Facilities Corp. has been available for some time. Tremendous strides have been made recently in the art of compounding Buna S, particularly in the use of super-fine furnace process carbon blacks and also in the use of so-called "oil-extended" polymers. The accompanying table lists some comparative characteristics of natural rubber and GR-S to suggest where the use of one may be more advantageous.

Butyl rubber has been used in inner tubes for some time. Recently, other automotive products have been added, because it is the lowest priced elastomer available, and it has good weather resistance, flexing properties and tear resistance. The increased emphasis on color in automotive styling will affect the application of butyl rubber in exposed parts. Low price, heat and weathering resistance, availability in colors are among the advantages. Poor oil and fuel resistance and poor set characteristics, more difficulty in processing were among disadvantages noted.

A new type butyl polymer was an-

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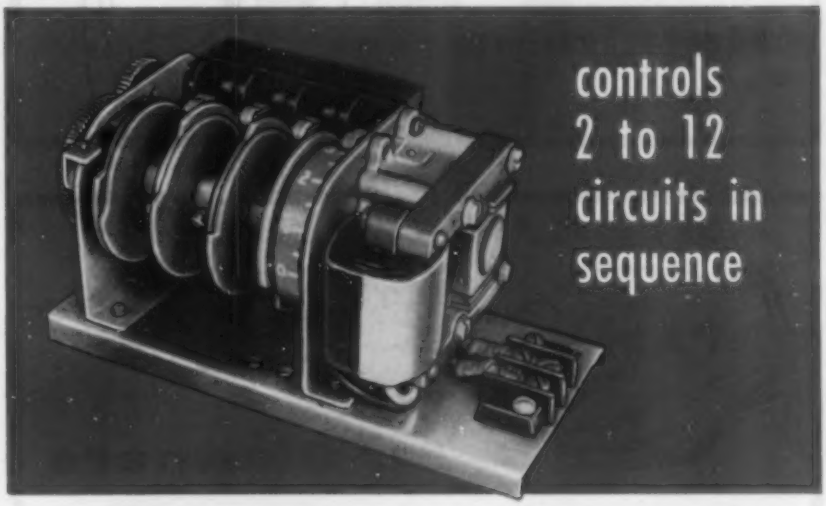

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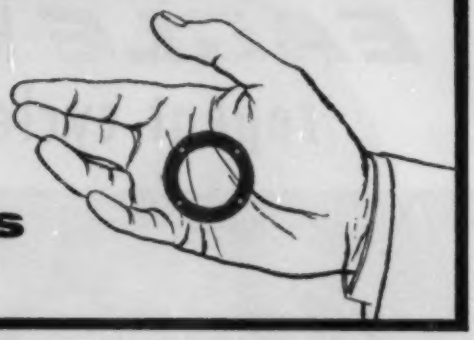

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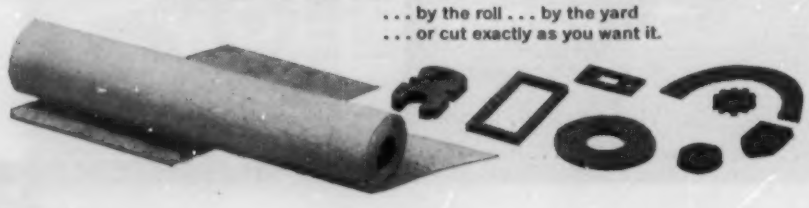

nounced recently by the B. F. Goodrich Chemical Co. under the name Hycar 2202. One of the disadvantages of butyl rubber is that it can be contaminated when even small amounts of ordinary sulphur vulcanizable rubbers such as natural rubber, Buna S and Buna N become mixed with it. The bromine modified butyl, however, can be mixed with other polymers or vulcanized adjacent to them and still be satisfactorily cured.

Neoprene has good weather resistance, flex cracking resistance, low permeability to gases, along with fairly good oil resistance.

During the past two or three years new types have been developed. One of these type "W," has a lower compression set than Neoprene GN without losing the other advantages.

Recently another new type known as WHV has been developed. This is a high viscosity W type neoprene, which has physical properties that are adequate for a number of applications, and at the same time costs less than standard neoprene compounds.

Buna N compounds have been available for seals and other applications requiring excellent resistance to oils and fluids since shortly before World War II. By varying the ratio of butadiene and acrylonitrile, it is possible to produce a number of varieties of Buna N with varying degrees of resistance to oils and fuels and with varying degrees of low temperature flexibility.

For some time considerable effort has been expended to develop seals from a newer type of synthetic rubber known as polyacrylic rubber marketed under the trade names Hycar 4021 and Acrylon. Compounds made from these rubbers will withstand 300 F dry heat for indefinite periods, whereas the best Buna N compounds usually remain flexible for only one or two days at this temperature.

At the last meeting of the Rubber Div., American Chemical Society, a new type of polyacrylic rubber was announced. Known as Poly FBA, it has low swelling characteristics in oils and fuels with substantial aromatic content, along with low shrinkage in high aniline point oils. Like standard polyacrylic rubbers, the new fluorinated type has the drawback of rather poor low temperature properties. A few preliminary tests have indicated

a remarkable resistance to oils (both low and high viscosity), extreme pressure lubricants, fire resistant hydraulic fluids, and dry heat. Not enough data have been accumulated to fully evaluate the new material, but it looks promising. Its present price is extremely high because it is being made in the pilot plant, and to some extent its acceptance will be determined by its ultimate production price.

Silicone rubber, of course, is valuable because of its wide useful temperature range. Compounds, flexible at −130 F, are available, and in many applications, parts made from these elastomers are exposed to temperatures up to 500 to 600 F. Although considerable improvement in tensile strength, tear resistance and abrasion resistance has been made, silicone rubbers are still more deficient in these properties than organic type polymers, such as Buna N and neoprene. Silicone rubber-glass fabric laminates are being fabricated into boots and other parts requiring some strength and resistance to flexing. Improvements in the compression set of this type of elastomer, especially at higher temperatures (300 to 400 F) have increased its use in seals.

Kel-F elastomer has unusual resistance to corrosive chemicals, oils, fuels, extreme pressure lubricants, and many other fluids. It can be vulcanized to form compounds with high tensile strength (up to 3800 psi), and good tear resistance. It is reputed to have exceptional heat resistance, and excellent weather and ozone resistance. These characteristics combined with its outstanding resistance to many fluids should make it a valuable material for seals of many kinds. Because this material is new and the supply has been so limited, it has not been possible to fully evaluate it.

Philprene VP is one of a new polymer family that will soon be competing with the other oil-resistant synthetic rubbers. Developed by the Phillips Petroleum Co., these new polymers are claimed to be unique in their ability to cope with cold, heat, and most types of oils and fuels. It probably will be at least a year before a full evaluation of the commercial possibilities can be made.

Vinyl polymers (polyvinyl chloride, polyvinylidene chloride, polyvinyl

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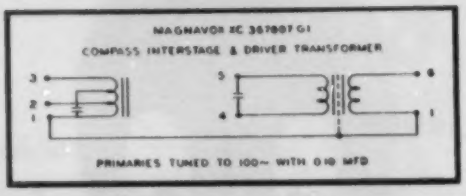

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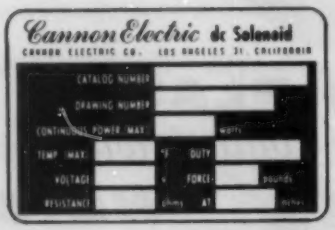

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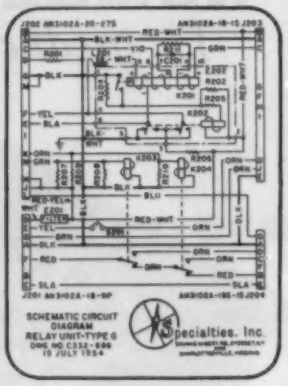

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chloride acetate) are now being used in a number of applications that were formerly filled by natural or synthetic rubber compounds as well as in many trim and upholstery parts formerly made from cloth or leather. The good weathering properties as well as the varieties and depth of color that can be obtained with this material have led to its use where appearance is important. Vinyl compounds are being successfully used for fender welts, seat welts, upholstery materials, window weatherstrips, door locking knobs, interior insulators. The excellent electrical properties and corona resistance are useful for distributor cap nipples and other electrical system parts.

Hypalon is a synthetic rubber or rubber-like plastic which has been commercially available only for two or three years. It is a polymer somewhat similar to neoprene that has unusual resistance to ozone and a variety of chemicals (acids, alkalies, etc.). Since compounds with good properties can be made without the use of carbon black, it is possible to produce almost any desired color.

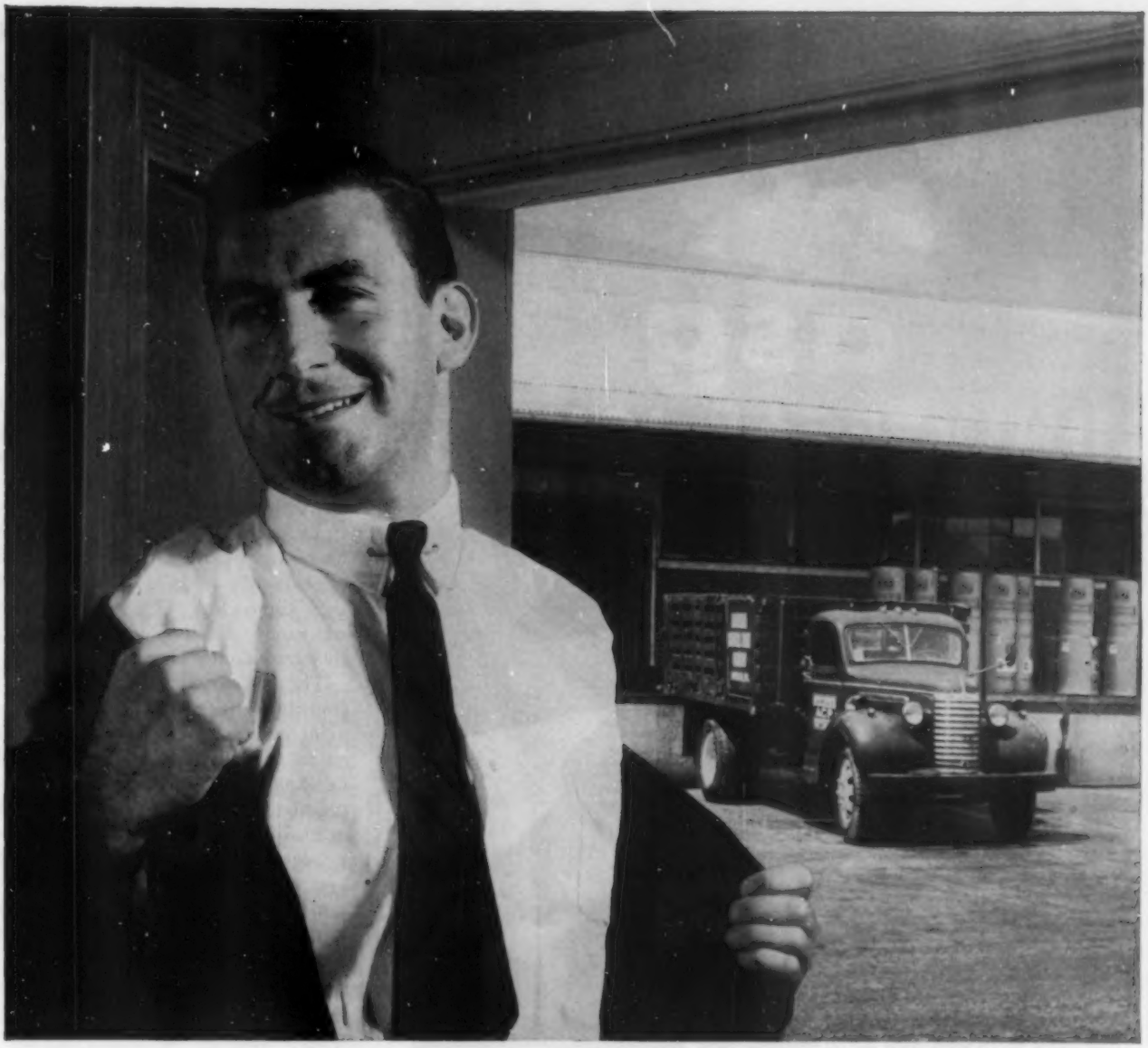
Polyester isocyanate elastomer foams are already being used in this country. They have low density, excellent strength and resistance to oils and weather. Because of its good tear resistance, trim pads made from isocyanate foam can be sewn together. (Foamed rubber tears readily when attempts are made to stitch it in place.) Some of the disadvantages of this new material are its limited heat resistance, and its relatively poor resistance to steam and hot water.

Do Engineers Need Executive Development?

Abstracted from "Do Industrial Engineers Need Executive Development?," by Harold F. Smiddy, Vice President, General Electric Co., New York, N. Y., *Advanced Management*, May 1955.

"Does anybody in industry need executive development?" The answer is: "Everybody needs it." "Who is responsible for executive development?" The answer is that, first and foremost, you are, and this responsibility is as much a part of your professional obligation as is your technical ability in your particular kind of work.

When we speak of executive development, what we really mean is man-



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aged development. There are two basic kinds of work in any kind of team effort. One, the work of the individual contributor, is where results are obtained through the direct application of aptitudes and skills to a particular task. The other, the work of a professional manager, is where the task is to exercise leadership in planning, organizing, integrating and measuring to set sound objectives and to attain them primarily through the work of others.

No matter if you do or you do not choose managing as a career, you have to have manager education. The main elements of the work of managing include planning, organizing, integrating and measuring. I think that all of us who have ever gotten anything at all done in our business life have used such approaches. The trouble is that we often do this intuitively and, therefore, do not always do it well.

The first reason that the individual contributor needs manager development is that some of the skills which guide the work of the professional manager, can, with little or no modification also make vast improvements in his own personal performance, providing he knows what they are and how to apply them. The second reason is that it is the best way he can learn and use what may best be called the "Managerial Attitude."

There is a need present in every job to realize that it has parallel responsibilities. First, there is a functional responsibility which calls for the attitude of the expert and to do your particular assigned task efficiently and effectively, and on time. It deals, if you are an engineer, primarily with technical problems and calls on your knowledge and skill in the engineering sciences. Second, there is this very big responsibility to integrate activities into the work of the business as a whole. This calls on knowledge and skills in the managing science. It is the relationships, or teamwork, part of over-all "work and teamwork" responsibility.

Each man in an industrial organization has a large "say"—expressed by his own attitudes and actions—in determining the manager's course. If he has what we call a "managerial attitude—the ability to see his particular sphere of work and the results of his work as part of the net accomplishment of the team—his manager can

lead by persuasion. If he does not, he necessarily invites being led by command.

This sort of thing is within the man. It needs to be overcome through individual effort and through the self-development of a mature understanding of the processes of business over and above primary centers of purely personal interest. It is the managerial attitude which needs to be acquired. When managerial attitude is lacking, we have started to sow the seeds of our industrial destruction, and our industrial destruction would wash individual engineers and their managers down the same drain.

There is plain need to begin at least elementary—yet very specific—manager education in the colleges and graduate schools of our universities. Unless somewhere along the line we were educated to look at our own work within the circle of the common objectives, common interests and common purposes of our business—and, indeed, to look at our business within the far larger boundaries of the common good of all people—I submit that we are not, in the true and practical meaning of the word, professional anythings. Perhaps, then, we should re-evaluate our professional education techniques: less of physics and more of people, less of steam tables and more about dinner tables. It may, at least, be the proper beginning of manager development—which our analysis shows, in the final sense, is self-development.

It is possible for you, as a part of industry, to contribute to the development of executive attitudes in two ways. First, there is personal self-development, for, no matter where we happen to stand on the chart of organization, each of us, alone, is responsible for learning all the skills we need. This is not the kind of job you can set aside either. While you worked, ate or slept, the world you knew made some changes, and the successful man needs to race and walk to keep up with them. It is a challenge which gets bigger as we come to know more about it.

Second, there is a responsibility for guiding, counseling and teaching those with whom we work. This, though it is a major concern of the professional manager is, in very large measure, a common responsibility of the individual contributor, and, in-

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	Tensile Strength psi as cast	41,000	47,600
	Tensile Strength psi after 10 years indoor aging	35,000	39,300
	Elongation % in 2 in. as cast	10	7
	Elongation % in 2 in. after 10 years indoor aging	16	13
	Expansion (growth) inches per inch after 10 years indoor aging	.0001	.0001
OTHER PROPERTIES AND CONSTANTS (AS CAST) *	Brinell Hardness	82	91
	Compression Strength psi	60,000	87,000
	Electrical Conductivity—Mhos/cm at 20°C	157,000	153,000
	Melting Point—°C	386.6	386.1
	Melting Point—°F	727.9	727.0
	Modulus of Rupture psi	95,000	105,000
	Shearing Strength psi	31,000	38,000
	Solidification Point—°C	380.6	380.4
	Solidification Point—°F	717.1	716.7
	Solidification Shrinkage—Inch/Foot	.14	.14
	Specific Gravity	6.6	6.7
	Specific Heat—cal/g/°C	.10	.10
	Thermal Conductivity—cal/Sec/sqcm/cm/°C at 18°C	.27	.26
	Thermal Expansion per °C	.0000274	.0000274
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In my own company, General Electric, we embarked some years ago on an intensive study of the development of men, and in the past year we have been able to bring what we learned to the level of use in the sense of making definite improvements in our previous development approaches.

Production of Metal Powder Parts in Small Volume

Abstracted from "The Economic Production of Metal Powder Parts in Small Volume" by B. I. Horton, Methods Engineer, Pitney-Bowes, Inc., Stamford, Conn.; presented at Metal Powder Assoc. Mtg., May 11-12, Philadelphia, Pa.

On production quantities as low as 10,000 per year or less, considerable savings are realized and tool costs amortized quickly—usually under two years.

After purchasing several metal powder parts for approximately two years, and during this time gathering considerable information about the process, it was evident that greater savings could be realized and control of the manufacturing maintained by establishing a metal powder department.

It was now possible to show management that substantial savings were being made, even though total production quantities were still very low. Cost comparisons against previous manufactured costs showed savings ranging from 10 to 90 per cent. A large factor in this cost reduction was undoubtedly the method established for operating the production of metal powder parts. One person was made responsible for complete control of the process. It was his job to educate tool and product design engineers, approve or correct their designs or reject them where the application or design was not feasible, make the necessary cost analysis to determine feasibility from an economic standpoint, select tool sources, and establish the required process specifications.

After two years, approximately 35 different structural parts and 90 different self-lubricating bearings were being produced from metal powder.

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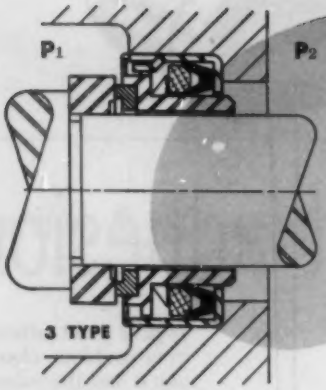

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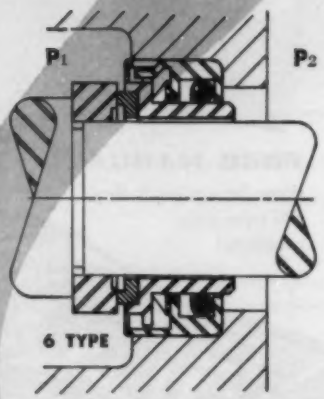
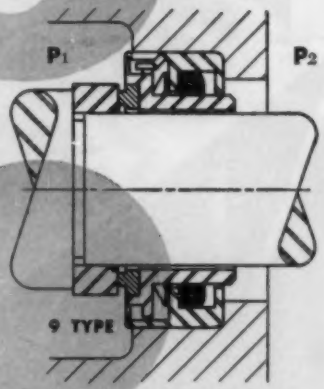


P1 greater than P2
1000 psi maximum differential



P2 greater than P1
350 psi maximum differential

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groups of parts, self-lubricating bearings and structural parts, the savings were approximately 15 per cent on the bearings, comparing against purchased parts, and between 60 and 70 per cent on the structural parts.

Additional emphasis was placed on educating design sections on use of the metal powder process as an initial production method and instructing them in designing new parts for the process.

As parts were produced that had been designed in this manner, cost comparisons were made against alternate methods of manufacturing. In most cases, the quantity of parts required to obtain savings was 10,000 per year or less, and in many cases only 1,000 per year. Savings ranged from 40 to 80 per cent and tool amortization time was less than two years.

Cost analysis was carried out for a two-year period to determine savings. About 55 structural parts showed an average saving of about 70 per cent.

Following are the main reasons for success in low volume production:

(1) Product design. Parts properly designed for the process cause many less variables than those made as a substitution for another process.

(2) Tool design and the workability of the tooling. This is common to any type of metal powder production.

(3) Standardization of parts, such as self-lubricating bearings. By this method, one set of tools can sometimes be made so that they can be used for numerous parts.

A good example of cost reduction by standardization is the possibility of eliminating duplicate and almost identical parts. When self-lubricating bearings were standardized for production, parts were discovered that differed in dimension only by tolerance. By eliminating these parts and numerous other bearings that could be readily substituted with a bearing of almost the same size, the number of different bearings required was reduced from 140 to 93.

Standardization of inside and outside diameters aided from a tooling standpoint by making possible production of 68 plain self-lubricating bearings from twelve sets of tools with additional punches and core rods.

(4) Process Control. Strict process controls in the hands of a limited number of people will tend to eliminate variables and re-work, which in low volume production is very costly.

NEW BOOKS

Fatigue of Aluminum

R. L. TEMPLIN, *Assistant Director of Research and Chief Engineer of Tests, Aluminum Co. of America, New Kensington, Pa. 6¼ x 9¼ in., 59 pp. Published by ASTM, 1916 Race St., Philadelphia 3, Pa.* $1.50.

The third H. W. Gillett Memorial Lecture was presented at the 57th Annual Meeting of ASTM in Chicago, Ill., on June 15, 1954. The lecture is a detailed treatise supported by 497 bibliographic references, 27 figures and 4 tables. The lecture reflects the author's experience of 35 years in the field of investigating the fatigue of aluminum.

Starting with a short discussion of fatigue phenomena and the fundamental mechanism of fatigue failures, the author goes on to evaluate fatigue properties and the factors affecting fatigue strength. Test methods are described and data shown. These cover metals other than aluminum, the different aluminum alloys and includes a report on fatigue data of cast versus wrought aluminum alloys.

The influence on fatigue strength of cold work and heat treatment, grain size and orientation, inclusions and voids, internal strain and size effect are explained. This part of the discussion is concluded with notes on coatings and platings, environmental protection and stress raisers and their effects on fatigue strength.

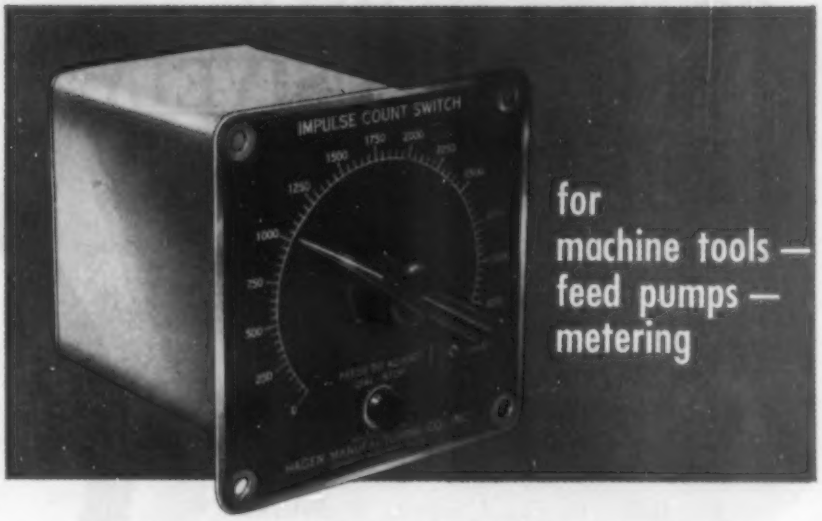
This lecture, presented in book form, is a noteworthy treatment of the subject of fatigue and design engineers and metallurgists should find it a valuable reference because of its completeness.

Dimensions and Tolerances For Mass Production

EARLE BUCKINGHAM, *8½ x 11 in., 164 pp. Published by Industrial Press, 148 Lafayette St., New York 13, N. Y.* $8.

In this book the author proposes improved methods and practices to meet the problem of dimensioning

HAGEN count switch



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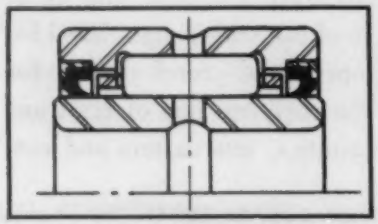

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with tolerances, and discusses their relation to production design, tool design, gage design, production and inspection. In analyzing the uncertainties in present-day practice, he points out that the actual method of expressing dimensional information is of secondary importance. What is important is the recognition that several kinds of dimensions are needed on component drawings, and that several types of conditions must be definitely controlled by tolerances. In brief, the thesis is that all limiting conditions must be controlled by definite inspection procedures and it must be possible to translate every limiting dimension into a definite design and size of an inspection gage.

It is shown how limiting dimensions on detail drawings control conditions of bulk or size, conditions of form, conditions of position, and conditions of assembly, operation or functioning. Also it is shown how the method used to specify permissible tolerances may need to be different for each of these conditions.

Two chapters, each devoted to a specific product, illustrate step by step, how the methods developed in the book are applied in controlling limiting conditions by the use of various types of dimensional and functional inspection gages.

Servomechanisms and Regulating System Design

HAROLD CHESTNUT and ROBERT W. MAYER, *Aeronautics and Ordnance Systems Div., General Electric Co.*, 6 x 9¼ in., 384 pp. *Published by John Wiley & Sons, In , 440 Fourth Ave., New York* 16, N. Y. $8.50.

Volume I of this series presented the basic analytical tools for understanding and performing a major portion of the design work in feedback control systems specifically for engineers and students who had no previous training or experience in the field of closed-loop control. Volume II is directed to the practicing designer and presents necessary additional information to enable equipment dynamic requirements to be translated into control system design terms.

Volume II states the problems met in the design of regulators and control systems and develops methods

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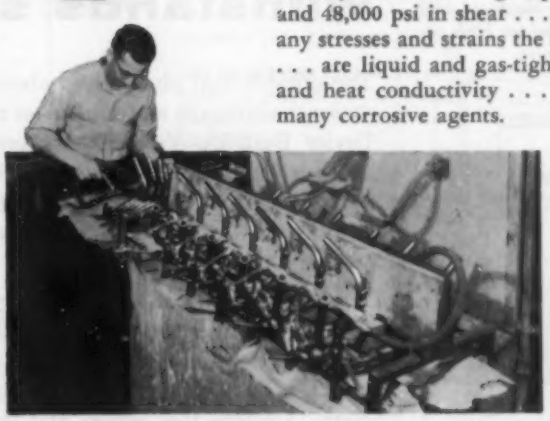

In the job shown here induction heating is used to braze steel handle bars to stems with EASY-FLO 35 – 6 at a time in 32 secs. The two jobs shown at left above are gas torch brazed with EASY-FLO 45.

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Shop Talk

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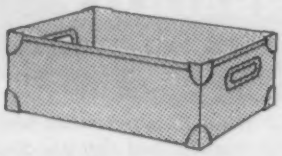
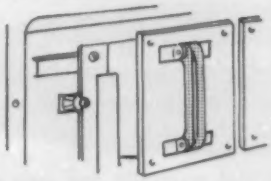
Tips for designers

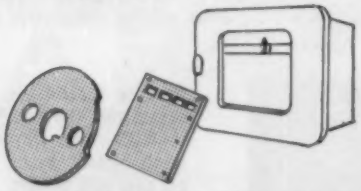
Insulated fibre screw drivers, made of high dielectric strength Taylor Fibre, are electrically safe, physically tough.



Tote boxes must withstand severe usage . . . an ideal application for tough, durable Taylor Vulcanized Fibre.



Fuse box handle formed from Taylor G-5 Melamine Laminate has high electrical and mechanical strength . . . provides high resistance against corrosive fumes.



Cam and terminal board for recording instrument is made of Taylor Grade XP Laminate . . . noted for its electrical insulating properties and ease of machining.

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Tip of 2" diameter Taylor Built-Up Vulcanized Fibre Rod used as drift pin for driving out stuck roll-up shafts in paper mill. Heavy sledge hammer blows on end of rod could not split apart the laminations at bond joints.

Taylor Built-Up Fibre withstands severest impact

The unretouched photograph above shows the strength and toughness of Taylor Built-Up Vulcanized Fibre. This is the tip of a 2" diameter x 36" long built-up fibre rod after more than a year's use as a crowbar and drift pin in a paper mill.

It was used as a bar to lift and pry 800 lb. objects. It was pounded with a 16 lb. sledge hammer in its use as a drift pin to drive out stuck roll-up shafts. Despite this severe and repeated abuse the rod was unbent. *And note that hundreds of sledge hammer blows have not severed the adhesive bonds between laminations.* Rather it is the fibre itself which has first failed. This is proof that built-up fibre is just as strong and as tough as homogeneous fibre.

Wherever exceptionally thick sections are required—for rods, plates, blocks—Built-Up Fibre can be produced in thicknesses up to 3 inches. Laminations are bonded together with specially developed adhesives to make a tough, solid mass.

For many applications, Taylor Built-Up Fibre can be used as a direct replacement for more expensive homogeneous commercial fibres. Moreover, it is available in a fraction of the delivery time. Outstanding physical and electrical properties make it the ideal material for heavy switchgear, arc barriers, insulating plates, rods, cutting blocks, bumper blocks . . . and a variety of similar uses.

Ask your Taylor representative about the numerous profitable applications for versatile Taylor Vulcanized Fibre and Taylor Laminates in your product. There are literally thousands of uses for economical, easy-to-form Taylor products.

for their solution. Although an analytical approach is employed, the emphasis is placed on practical design procedures. As such, this book provides a first chapter on measurement of quantities before, during and after the design process. Chapter 2 deals with the definition of user's requirements in terms of control-system design specifications. Techniques for defining both desired and unwanted signal inputs are presented. In Chapters 3 and 4 methods are discussed for selecting the power and stabilizing portions of the control system to meet the requirements of the signals defined in the previous chapter. The requirements of the servomechanism amplifier which matches the stabilizing elements to the power elements of the loops are discussed in Chapter 5, with particular emphasis on the design factors required to minimize gain changes and drift due to changes in tube parameters and other components. Chapter 6 is devoted to a-c servomechanism design.

Because of the importance of nonlinearities in control system design, the last three chapters are devoted to this subject. Chapter 7 deals with analytical techniques for linearization of systems having small excursions, while the approach used for large input signals is described in Chapter 8. In Chapter 9 some of the techniques which used nonlinear elements to improve system performance are discussed. Emphasis is placed on the physical picture involved as interpreted in terms of steady-state analysis and attenuation-frequency diagrams.

Turboblowers

A. J. Stepanoff, *Ph.D., Melville Medalist, ASME, Ingersoll-Rand Co.* 9¼ x 6¼ in., 377 pp. *Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $8.

In the last fifteen years unprecedented developments have taken place in the application of turbo machinery for the compression of gases and vapors. This book deals with the hydrodynamic and thermodynamic aspects of turboblower design. It outlines new methods of attack on turbomachine problems, and discusses the art of building turbocompressors in the United States and abroad.

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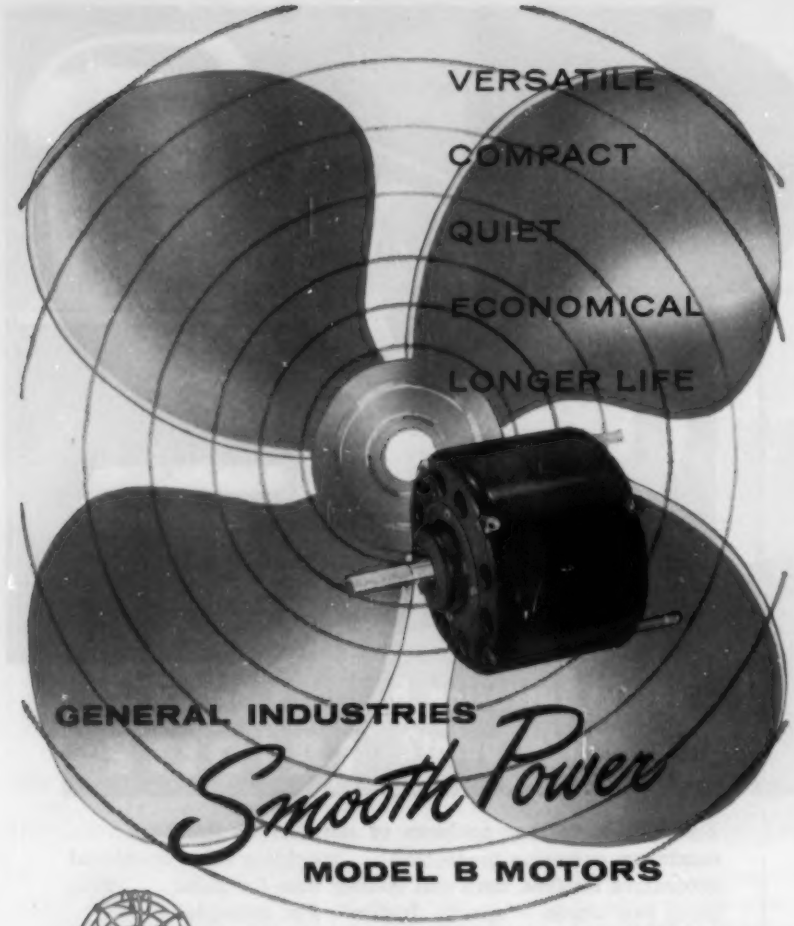

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B-8-CW B-8-CCW	1/60	2.7	13.0	1745	56	.80	2.7
B-10-CW B-10-CCW	1/50	3.0	15.5	1755	64	.88	3.1
B-12-CW B-12-CCW	1/40	3.4	18.0	1760	72	.95	3.4

NOTE: Direction of rotation when looking at end of shaft. CW indicates Clockwise. CCW indicates Counter-clockwise.

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past and current work in the field, the author presents a number of new methods and techniques. The theoretical treatment of the compressor impeller based on a single pattern of flow is extended to similar design procedure for both centrifugal and axial flow impellers. In contrast to the indirect thermodynamic basis commonly adopted in the past, the hydrodynamic nature of pressure generation is stressed. A large chapter is devoted to water cooling; here a design method is offered with detailed numerical examples and complete energy balance.

The author presents his own method of axial-flow compressor design based on actual fluid deflection and observed pressure and capacity coefficients, rather than lift and drag coefficients, which are a part of airfoil theory. The latter is discussed sufficiently to demonstrate its weaknesses and limitations. Also shown are ways by which the performance of fans can be improved with little increase in cost.

Interpretation of Engineering Data: Some Observations

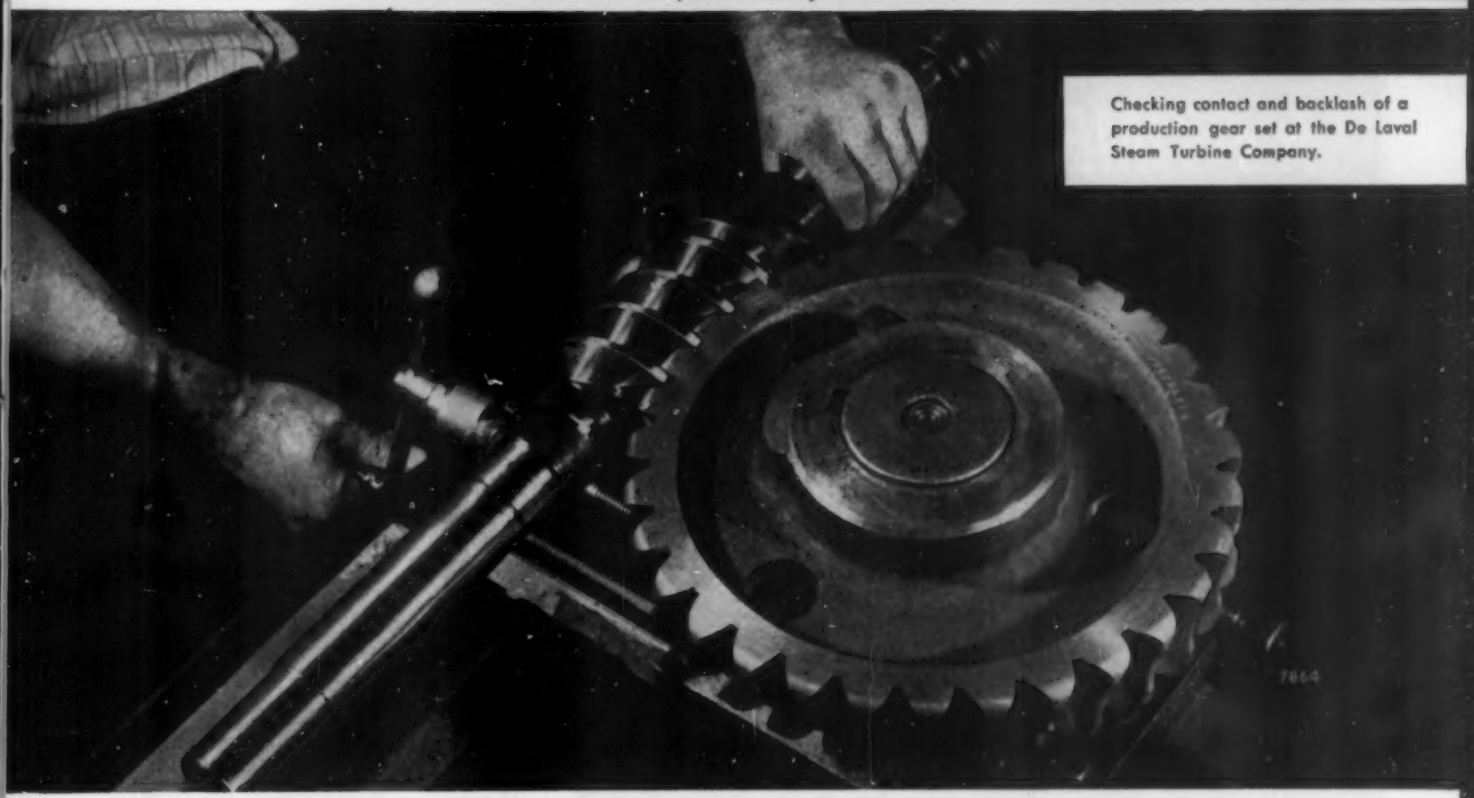
HAROLD F. DODGE, *Bell Telephone Lab., Inc.* 6 x 9 *in.*, 35 *pp, paperbound. Published by ASTM,* 1916 *Race St., Philadelphia* 3, *Pa.* $1.50.

This short booklet is a reprint of a lecture given before the American Society for Testing Materials. It is a discussion of the subject from the viewpoint of quality engineering and more particularly of sampling and quality control techniques.

Statistical quality control is based on concepts extremely difficult to grasp, but this necessarily brief paper is clear, concise and of practical use to the reader. Each thought is backed up with a pertinent example from the first, simple concept of sampling and frequency distribution, through the confidence limits and estimates of the various parameters.

"The engineer is constantly faced with the problem of drawing conclusions regarding the whole, or of deciding what action should be taken on the whole, when he has measured only a part."

Philosophical as well as mathematical logic is used to introduce this vast but useful subject to the reader



Checking contact and backlash of a production gear set at the De Laval Steam Turbine Company.

How to Save in Selecting Worm Gear Sets

By JAMES E. GUTZWILLER, *Assistant Chief Engineer, Worm Gearing Department*

De Laval Steam Turbine Company

Worm gear sets have four major advantages: compactness, easy maintenance, interchangeable components, and high shock-load capacity. The user can realize maximum benefits from these advantages and reduce costs by acquiring some background information on the characteristics of worm gearing. Here are a few points to consider.

Standard Components. Find out what standard components are available before proceeding with design. De Laval stock parts include worms, gears, bearing housings and end covers. By selecting from these, the user may sharply reduce the cost of the finished gear set.

HOBBING MACHINE — Tangential feed gives uniform teeth of precise dimensions. This is accepted as the most satisfactory method for producing close tolerance worm gearing.

The hob, for example, must match the pitch diameter, pitch, lead and tooth form of the worm. Designers who are familiar with standard hobs can design a worm accordingly and save the expense and delay of obtaining a special hob.

A Note on Assembly. The worm, having threads which are continuous in form, is not critical in regard to endwise location. The gear, however, must be precisely positioned in an axial position. Accumulation of tolerances on the dimensions of housings, shafts, bearings and gears makes it impractical, in most cases, to control the location of the gear by accuracy of machining alone.

Shrouding. Heat developed in the gearing will be more freely dissipated through a comparatively open housing. Close shrouding is permissible only when intermittent operation is the rule.

Helpful Manual on Worm Gear Sets

For information on how to select, install and maintain worm gear sets, send for this helpful manual. It contains useful data on gearing and includes examples of specific selection problems with their solutions. Write on your business letterhead to the De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, N. J. for Catalog 5000.

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unfamiliar with the field. The tools, the equations, are given and used, but the reader senses that only the barest surface of the subject is touched and the appetite for further investigation is whetted, as it should be in a lecture of this sort.

Thoroughly realistic throughout, we note in an illustrative problem on the estimation of a sample size to be taken: "He who is paying the bill weighs the value of greater precision versus the cost and comes down to some sample value that seems to strike a proper balance between value and cost . . . the mathematical model provides a basis for understanding; it gives a yardstick for measuring how good an answer can be expected for any given choice of constants."

Dynamics of Machinery

A. R. HOLOWENKO, *Assoc. Prof. of Mech. Eng. Purdue Univ.* 6 x 9 in., 464 pp. *Published by John Wiley & Sons, Inc., 440-4 Ave., New York 16, N. Y.* $7.50.

Many engineers may criticize the title of this book. It would be more appropriate to call it "The Principles of Dynamics of Machinery," since the coverage is mainly concerned with kinematics, mechanics, and balancing. Approximately 100 pages are devoted to the latter, including the balancing of both machines and engines.

The chapters devoted to kinematics include accelerations, velocities, and equivalent mechanisms. The mechanics coverage includes static forces, inertia forces, dynamic analysis and vibrations of shafts.

Waterhammer Analysis

JOHN PARMAKIAN, *Head, Tech. Engrg. Analysis Sec., Design Div., Bureau of Reclamation, Denver, Colo.* 6 x 9 in., 161 pp. *Published by Prentice-Hall, Inc., 70 5th Ave., New York 11, N. Y.* $6.50.

The author has organized much of the material published during the last 25 years into a useful introduction to the field of pressure surges in pipe lines. The theories of rigid and elastic water columns are derived and a graphical method offered which simplifies the laborious computation involved in the solution of waterham-

mer problems. Most of the subsequent discussion is based on this graphical method of solution.

In a series of short chapters devoted to specific pipe configurations the author discusses pressure wave reflection due to gate closure and opening, waterhammer in pump discharge lines and compound pipes, and the effects of surge tanks and air chambers in hydraulic lines.

Introductory Applied Physics

NORMAN C. HARRIS, *Instructor in Physics and Eng.*, and EDWIN M. HEMMERLING, *Instructor in Eng. Math., Bakersfield College.* 6¼ x 9½ *in.*, 729 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 W. 42 St., *New York* 36, *N. Y.* $6.75.

Recent advances in technology, not found in other physics books at this level, are included in this text with emphasis on present-day applications. For example: the topics of electronics, generators, motors, refrigeration, air conditioning, radio and television are given an emphasis corresponding to their importance to industry.

The text includes a review summary at the end of each chapter in a wide variety of solved problems. The book is liberally illustrated with photographs and diagrams and includes an appendix containing physical and electrical tables of reference. The mathematics requirement has purposely been kept on an elementary level. A modest ability in algebra and trigonometry is all that is required.

Tool Design

WILLIAM R. JEFFRIES, *Assoc. Prof. of Mech. Engrg., Montana State College.* 5½ x 8½ *in.*, 217 *pp. Published by Prentice-Hall, Inc.*, 70 *Fifth Ave., New York* 11, *N. Y.* $6.35.

Easy-to-follow, elementary book on tool designing, containing instructions on design of machine tool jigs, fixtures, weld and assembly fixtures, punch press tooling, hydraulic press tooling, methods of clamping and locating.

Also included are discussions on pressworking machine, pressworking tools and an appendix containing drafting data, standard drill bushings, die sets, and standard parts.

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Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Simplified Drafting Concept Misunderstood

To the Editor:

It is apparent from a careful review of several recently published articles that the basic concept of simplified drafting practices has been misinterpreted or misunderstood. The fact remains that simplified drafting is an accomplished fact and is being used successfully in many areas.

Many authors have pointed out the need for completeness, thoroughness, readibility, legibility and accuracy. These facts are acknowledged without reservation; in fact, they are enthusiastically endorsed. Since simplified drafting can be successfully applied, it should therefore be obvious that the basic concept does not condone sloppy, incomplete work.

The word "simple" means, among other things, "free from complexity; unadorned; free from elaboration; etc." A simplified drawing is one in which complexity has been minimized and all decorations and embellishments eliminated. The key to simplification is the elimination of drawing content that is beyond the point of necessity. Today's intense competition prohibits paying for beauty and adornment on production drawings. From an engineering viewpoint, such decorations and embellishments are out of place in a document which is intended to be characteristically functional in nature. The first principle of simplified drafting is to do everything that is necessary—to the extent or degree necessary—then stop!

Many articles on the subject have referred to the evils of "oversimplification", the implication being that any practice that is capable of being used to an extreme should never be applied in the first place, even in moderation. This argument against new ideas is completely contrary to the philosophy which is mandatory to progress. It is quite obvious that the simplification

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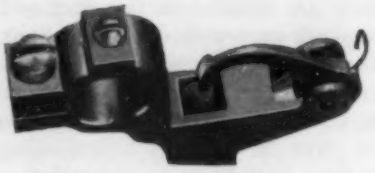
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of drawings can be carried to extremes that are injurious, but good judgment, based on sound knowledge of requirements and objectives, is the control over such mis-application.

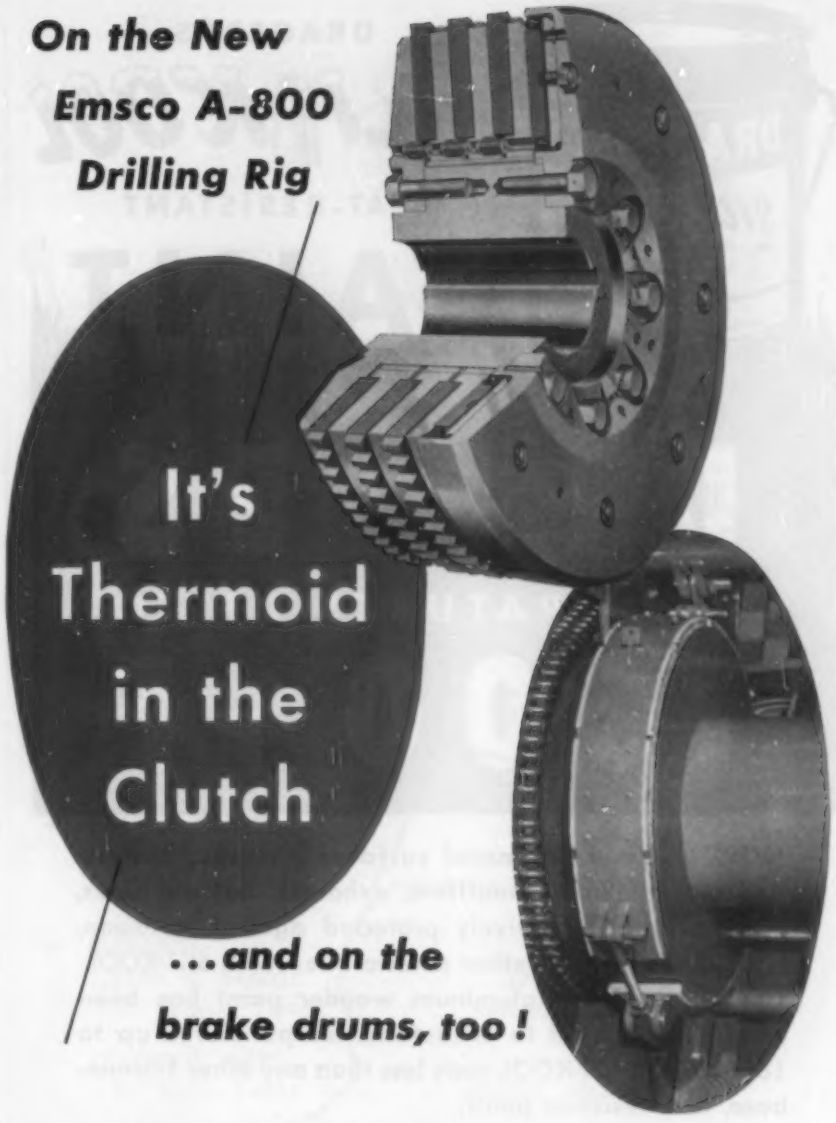
The second principle of simplified drafting relates to the means for conveying information. Drafting makes use of an engineering language and includes a "vocabulary" of defined meanings. A language becomes archaic and inadequate unless its development and usage is dynamic. Drafting must adopt a similar viewpoint if it is to avoid the consequences of archaism. It is ridiculous to even suggest that our fathers and grandfathers were able to develop ways and means for graphically representing engineering information that are incapable of improvement; there must be better, more expressive ways of conveying information.

A frequent area of criticism of simplified drafting is indicated by a statement in a recent article in your magazine (June 1955, page 193), "A simplified drawing may make sense for the few people who have the thorough training to understand it, but obviously this 'short-hand' method . . . cannot be used by the multitude." Nothing could be further from the truth! Among the multitude, there are two classes of people involved: those who read drawings, and those who make them.

From the user's viewpoint, a drawing which contains only the essentials to the job at hand (by definition, a simplified drawing) must certainly be easier to read and interpret than one which is littered and cluttered with data or lines of no particular interest or benefit. Actually such extraneous material must be mentally eliminated from consideration when interpreting a drawing, thus, adding to the effort expended and the opportunities for error. From the draftsman's viewpoint, there is also a reduction in effort, since there are fewer lines and fewer dimensions and notes. The major difference in preparing a simplified drawing is in the necessity for distinguishing between necessary and unnecessary information and delineation. But, since this type of attention to detail is a fundamental of good drafting in general, an effort toward simplification is actually a means of improving the overall stature of drafting.

There is also an implication made in

On the New Emsco A-800 Drilling Rig



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the statement quoted above through the use of the term "short-hand" that is quite common, and equally unfounded. Difficulty in reading any engineering drawing is frequently charged to some fault in preparing the drawing. It must be acknowledged that difficulties are just as likely to be due to the inability to read drawings or to the failure to educate the reader in the language of drawings and its vocabulary. Children cannot read until they are taught fundamentals. Mature people cannot read and secure understanding without more or less frequent references to the dictionary. For similar reasons, the language of drafting, irrespective of style, must be defined in a "dictionary", fundamentals must be taught, readers must be kept informed of changes and additions, and they must expect to feel it necessary to make occasional reference to the "dictionary". These basic concepts apply just as much to simplified drafting as they do to any other field of expression or communication. The fault lies, not in the concept, act or the process of simplification itself, but in the failure to make known the practices involved, and to educate users in those practices.

—W. H. Buchanan
Cincinnati, Ohio

Ed—In ancient times engineering drawings were primarily pictures of the product to be made. Later the "picturing" was simplified by showing in solid lines all the lines of demarcation in each of three separate views, and not showing any convergence. Later, dotted lines and sectional views came into use, but the language still remained a picture language. When the "language" is simplified to the extent of being no longer pictorial, such as omitting views, "x" marks for circular holes and not even showing a hole's edge distances, the language has been oversimplified. It becomes the difference between reading the written word and reading shorthand. Even the best of stenographers cannot read each other's shorthand with confidence.

Credit Lines?

To the Editor:

Your editorial in the June 1955 issue, "Too Much Pressure", is quite appropriate, and in the light of the descriptions in your department, "De-

sign Features in New Products" on following pages, it is amusing.

Wouldn't it be fine if your paper were to practice what you preach. Take for instance the highspeed printer developed by Burroughs Corp. and described on pp 144-149. It is an exceedingly complex and difficult piece of machinery. Why not start the story with a brief reference to the men who did the job. You might state the chief engineer's name and speak of the engineering group under his direction. Give the names of the project and assistant project engineer when describing one of their successful designs.

We readers are really interested not only in what, but in who did it. It would be really nothing more than a civilized courtesy. Did you ever see the published story of a development in the medical field that did not include the names of those who contributed to the success?

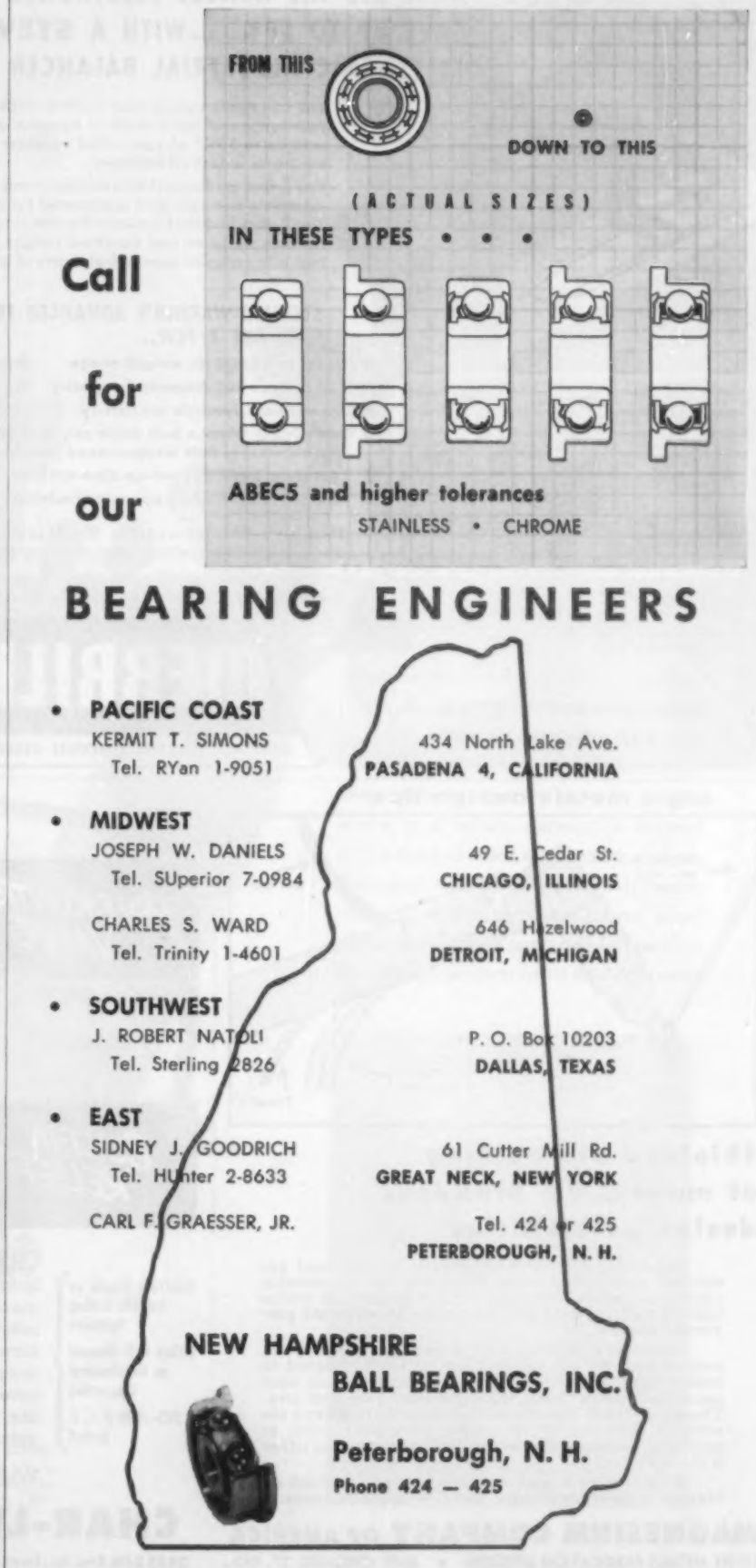
It would boost the morale and the social standing of the engineer and his profession a little. Is industry really so cheap that it cannot even afford this gesture? —HANS GROTH
Stillwater, Minn.

Ed—We are in 100 per cent agreement with your letter.

We would be glad to give the name of the chief engineer and the names of some of the men concerned with successful projects. However, only too many companies apparently refrain carefully from giving us the names of their engineers. They have a reason, although I don't agree with the legitimacy of the reason.

Every product of any size involves quite a few individuals. Usually the bulk of the work is done not by the chief engineer but his project engineers and the men down the line. The reason for this is that it often creates a lot of unhappiness in the company concerned when one man is given credit for the design of a product. The others who participated very properly feel that they have been slighted. I would feel the same way if I were in their shoes.

Of course I must confess that because we get rebuffed so often we probably don't try as hard as we should to get the names of the men who participate. Some of the companies do willingly give us the names. Your letter has served as a prod to exert ourselves a little more in getting the names of those engineers.



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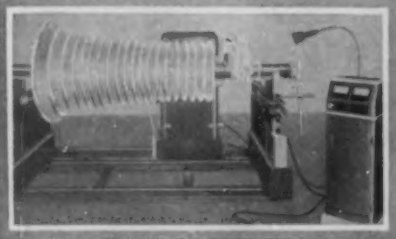

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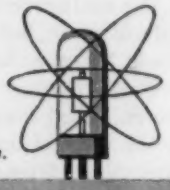

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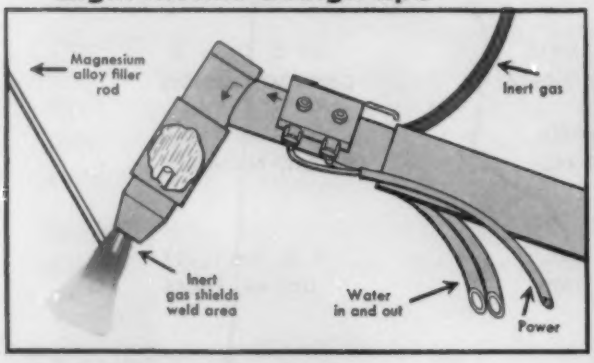

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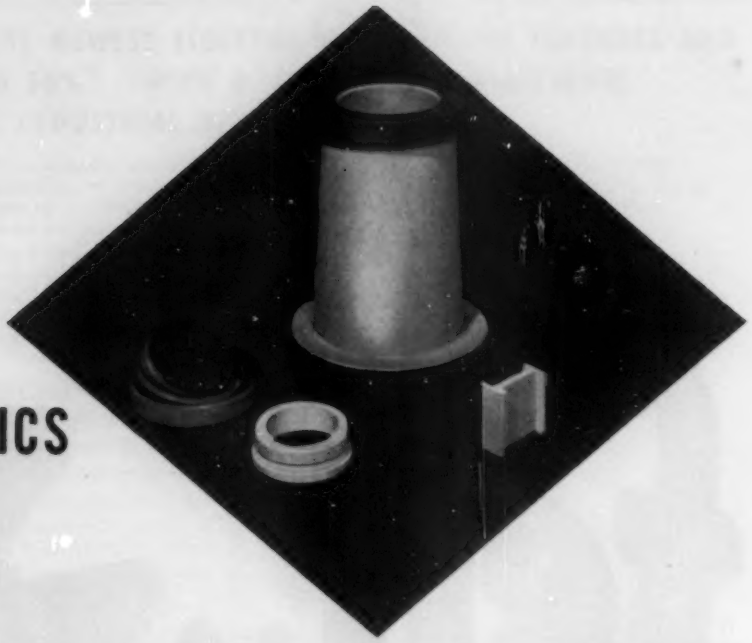

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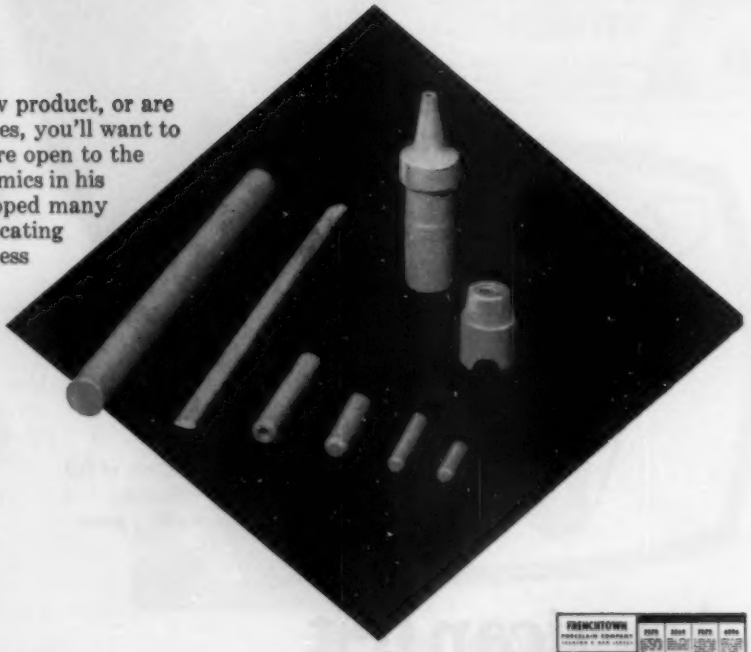

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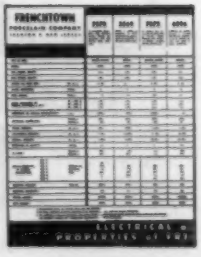

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TOUGHNESS: Good

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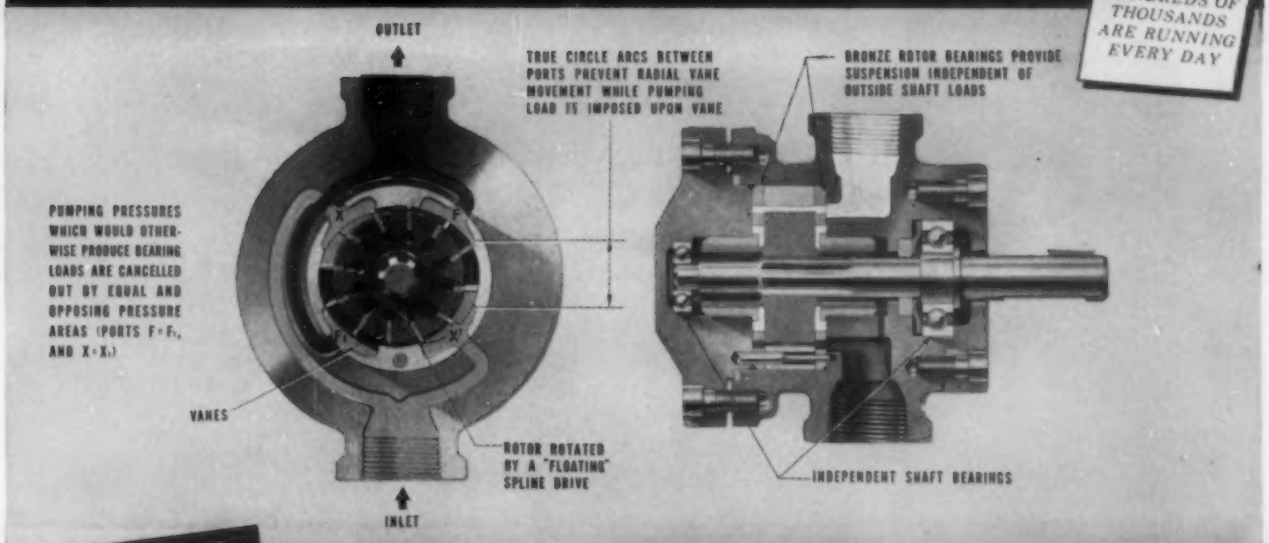
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TRUE CIRCLE ARCS BETWEEN PORTS PREVENT RADIAL VANE MOVEMENT WHILE PUMPING LOAD IS IMPOSED UPON VANE
BRONZE ROTOR BEARINGS PROVIDE SUSPENSION INDEPENDENT OF OUTSIDE SHAFT LOADS
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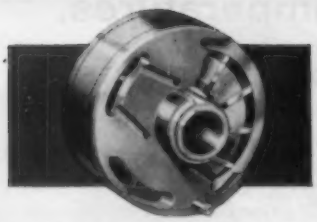
VANES
ROTOR ROTATED BY A "FLOATING" SPLINE DRIVE
INDEPENDENT SHAFT BEARINGS
INLET

Answer:

Because of their SUPERIOR PERFORMANCE and MANY OTHER BENEFITS for the user.



For more than two decades, the Vickers Balanced Vane Type has held the leading position among hydraulic power pumps . . . growing steadily in popularity. The various models (see below) are *the most widely used of all pumps in oil hydraulic service.*

Above is the pumping cartridge which is one of this pump's distinctive features. The many advantages listed at the right merit the thoughtful attention of anyone concerned with the selection and use of oil hydraulic pumps.

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COMPLETE HYDRAULIC BALANCE—Each inlet and outlet port is balanced by another equal in size and radially opposite . . . pressure-induced bearing loads are thus eliminated. Pressure-balanced porting plates maintain ideal running clearances.

FLOATING SPLINE DRIVE—Rotor is driven by a "floating" spline. Rotor and shaft have separate bearings . . . avoiding strain from drive misalignment.

TRUE-CIRCLE CAM ARCS between ports prevent radial vane movement while pumping load is imposed upon vanes. Wear between vanes and rotor is thus practically eliminated.

ABILITY TO TOLERATE DIRT—Clean oil is of great importance in a hydraulic circuit; but, in spite of care, dirt sometimes gets in. The Vickers Vane Type Pump will pass a reasonable amount of dirt without trouble and without grinding it up.

REPLACEABLE CARTRIDGE—Cartridge (illustrated above left) contains all pumping parts that move . . . none contact the housing. Working parts can be removed and inspected without disconnecting piping or drive coupling. Replacement cartridge kits are available and pumps need not be sent to the factory for repairs. Pump capacity can be changed by simply changing cartridge in the field.

HIGHER EFFICIENCY—Tests prove exceptionally high volumetric and overall efficiency . . . not only when pump is new but also after long service.

AUTOMATIC WEAR COMPENSATION—Vanes are held in contact with the cam ring by centrifugal force and hydraulic pressure. If wear occurs, vanes revolve in a slightly larger orbit without appreciable change in performance.

MINIMUM MAINTENANCE—Hydraulic balance . . . floating spline drive . . . independent bearings . . . automatic wear compensation eliminate the most important causes for maintenance and repair.

TEMPERATURE ADAPTABILITY—Correct running clearances are automatically maintained which compensate for wide variation in oil viscosity resulting from temperature variation.

LONGER LIFE—The numerous features mentioned above that keep down maintenance also contribute to longer life. Then, a new cartridge completely rejuvenates the pump.

CONSTRUCTION SIMPLICITY is evident from the illustrations above. This simplicity is another reason for the superiority of Vickers Vane Pumps. For further information, ask for Bulletin 7182

ALL MODELS HAVE THE VICKERS ADVANTAGES MENTIONED ABOVE

Single Stage. Pressures to 1,000 psi. Capacities to 55 gpm.

Two Stage. Pressures to 2,000 psi. Capacities to 55 gpm.

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Two-Pressure Pump automatically delivers larger volume at low pressure and smaller volume at high pressure.

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Failure from abrasion or from impact can happen to the steel in your equipment, too. Here's the answer—the tougher steel you've been looking for. Lukens "T-1" steel has excellent resistance to the combination of wear and impact, is tough enough to withstand unusual stresses and pressures as well as shock at either sub-zero or high temperatures, thus lowering maintenance costs and lengthening equipment life.

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answers a broad range of recording problems

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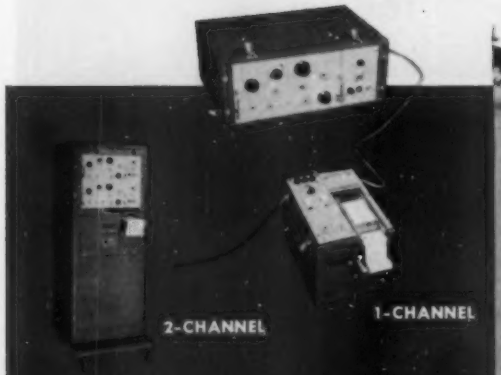
WIDE BAND DRIVER AMPLIFIER AND POWER SUPPLY

THIS amplifier (Model 150-300/700) is designed for use with low power galvanometer elements (output ±25 ma full scale into 100 ohm load), an oscilloscope and/or a panel meter, individually or simultaneously. Eleven plug-in type, interchangeable Preamplifiers are available for use with it, and include: AC-DC, Carrier, DC Coupling, Servo-Monitor, Log-Audio, Low Level, Input Network, AC Wattmeter, Frequency Deviation, Stabilized DC, and an RMS Volt/Ammeter.

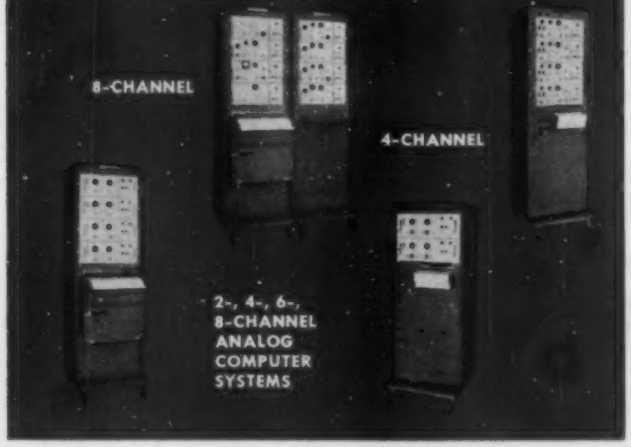
Other available separate components include Recorder Assemblies from 1- to 8-channels, with chart speeds from 0.25 to 100 mm/sec.

A "component" application

FOUR Model 67-300 DC Amplifiers and a Model 154-100 four-channel Recorder Assembly are integrated with other equipment aboard a "flying geophysical laboratory" by PSC Applied Research, Ltd. of Toronto to record data from dual frequency detector magnetic survey equipment and a radiation detector, plus elevation variations during flight. The simultaneous recording of all four provides valuable reference data when interpretations are being made.



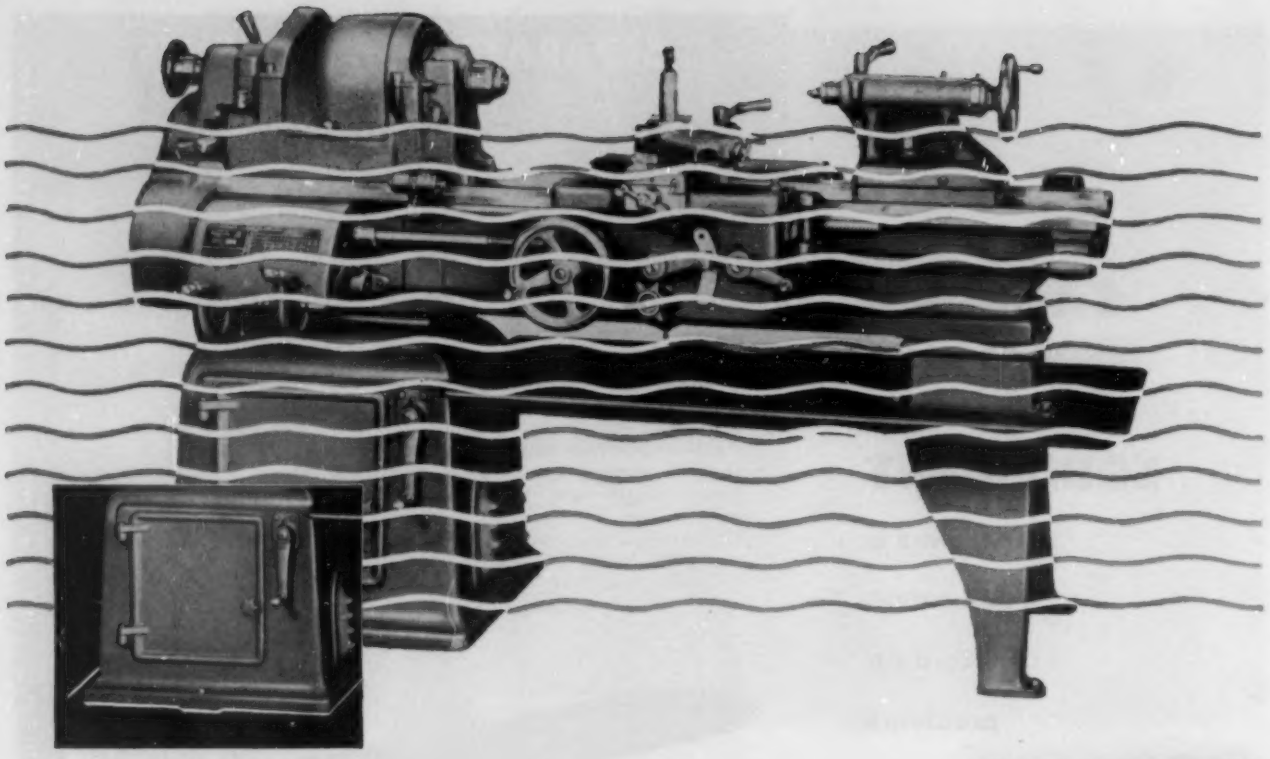
COMPLETE SYSTEMS



A Sanborn "150" system starts with a choice of an 8-, 6-, 4-, 2- or 1-channel basic assembly, to which the user adds any combination of plug-in type Preamplifiers to meet the numerous and changing recording requirements. Special 8-, 6-, 4-, and 2-channel systems are available for recording the output of analog computers, or other applications involving 1 volt/cm sensitivity. Added to this application versatility and operating flexibility of Sanborn systems are other advantages, such as inkless recording in true rectangular coordinates . . . high torque (200,000 dyne cm) galvanometer . . . time and code marking . . . numerous chart speeds.

Let Sanborn engineers help you solve your recording problems. Write for complete specifications and performance data on any Sanborn component or system.

SANBORN COMPANY
INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS



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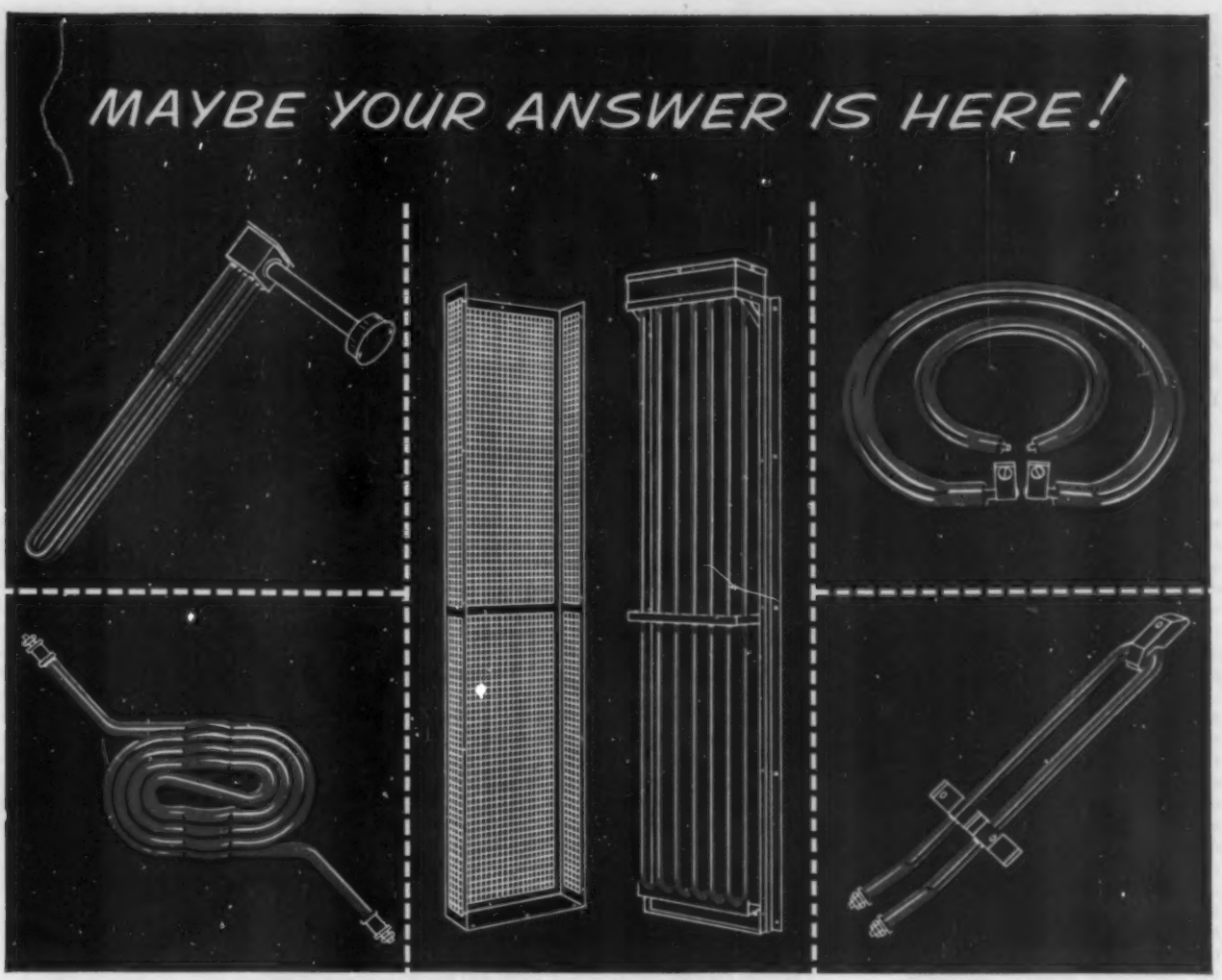

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Reynolds

ALUMINUM REPORTER

★ ★ ★ Nineteenth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

ALUMINUM DIE-CASTINGS CUT UNIT COSTS UP TO 75% FOR BELL TELEPHONE LABORATORIES

Aluminum in Composite Metals Finding More Important Applications

The many recognized advantages of aluminum are becoming increasingly important in composite metals to design engineers in many fields. Composite or clad metals have been widely used for many years—two of the oldest such composites are the clad high-strength aluminum alloys employed in the aircraft industry, and steel clad with aluminum to provide greatly extended life in high-temperature applications.

Top. Cable connector employing ALCUPLATE shims. Bottom. Rectangular wave guide tubing for radar work made of aluminum with coin silver lining and copper clad outside layer

One of the most recent applications indicating the important possibilities of aluminum-clad metals is the aluminum-clad low-carbon steel used to replace pure nickel in many electron tube elements. The clad metal not only replaces the nickel satisfactorily but reduces costs by eliminating the carbonizing operations required when using nickel.

Another composite metal of interest is ALCUPLATE, consisting of a layer of aluminum bonded to a layer of electrolytic copper by a solid phase bonding process which assures the absence of objectionable voids, oxides, and compound inclusions. The strength of the bond is equal to that of the aluminum. The most popular applications employ aluminum for 80% of the thickness, copper for the remaining 20%.

ALCUPLATE is an excellent conductor of heat and electricity since there is nothing between the aluminum and the copper to offer any resistance. This metal is especially useful in solving termination problems in electrical conductors where aluminum members must connect into copper fittings.

Another composite metal that has proved highly useful is ALSIPLATE, consisting of layers of aluminum and fine silver bonded together. ALSIPLATE tubing is widely used in radar and ultra high frequency radio work where the fine silver lining provides for highly efficient transmission of energy in wave guides carrying signals from transmitter to the antenna or radiator.

For more complete information, write for your copy of the Reynolds Technical Advisor, No. 30. to *Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Ky.*

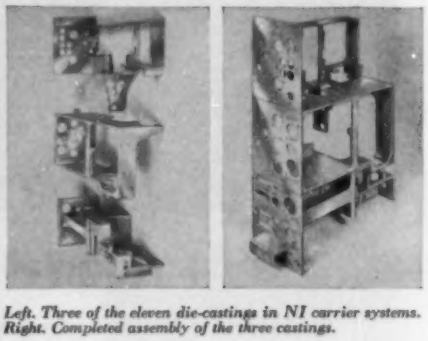
Small Production Not Necessarily a Limiting Factor

Although aluminum die castings are a familiar cost saver in the manufacture of large quantity items, Bell Telephone Laboratories have recently effected a major saving using die-cast aluminum for limited production of carrier telephone equipment units.

Pointing out that generally an item of fair complexity with an annual demand of around 5000 probably justifies die-casting, L. Pedersen of Bell Laboratories nevertheless selected this method for producing several items with as small an annual requirement as 1000.

These units are part of the trend toward miniaturization of telephone equipment. In designing for this goal, the engineer benefits from the use of aluminum die castings because the various mounting surfaces, as well as small pockets or compartments are easily formed in the casting process without the need for machining or other fabrication steps. Properly designed, die-castings incorporate details that otherwise must be mechanically fastened to the fabricated framework. Equipment designations and control identifications can be incorporated in the die by using raised characters in recessed areas instead of by printing or identification plates. The uniformity of aluminum die-castings shows to great advantage on the assembly line. Misalignments and necessary adjustments typical in parts fabricated by other methods are eliminated with properly designed castings.

In addition, Bell selected aluminum because of its light weight, low cost, dimensional stability, good electrical shielding properties in the carrier frequency range, and the practical nature and pleasing appearance of the natural aluminum finish. Aluminum alloys form a thin transparent oxide surface film which, for many uses, is sufficient protection for the part, and no further finishing is necessary — an important item when cost is a design consideration.



Left. Three of the eleven die-castings in N1 carrier systems. Right. Completed assembly of the three castings.

The requirement for N1 carrier systems is approximately 1000 a year. Eleven different aluminum die-castings are needed and a completed system requires from two to as many as twenty-four castings of one kind. Even assuming minor casting changes, Bell Laboratories found that the savings with aluminum die-castings would, if necessary, justify complete retooling after completion of 100 systems. With an annual demand of 24,000 for each of the three N1 castings, illustrated, costs were shown to be only about one-fourth those for other fabricating methods.

The group transmitting unit of the N1 system requires about 1000 die-cast chassis a year. With this relatively small demand, drilling and tapping a number of holes, and the part's share of the die cost amortized over a four-year period, the unit cost was only half that for other ways of fabrication.

Reynolds does not produce die-castings but will work with you to an unbiased solution of your design problems. For this assistance call your nearby Reynolds office listed under "Aluminum" in classified phone directories, or write to *Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Kentucky.*

Delo Finds Aluminum Best For Screw-Machined Chair-Leg Caps

In manufacturing modern metal chair and table leg-caps for Troy furniture, the Delo Screw Products Company of Delaware, Ohio, has selected aluminum screw-machine stock. The superior machineablity of free-cutting 2011-T3 aluminum, its economy, and efficiency, all contributed to Delo's selection of aluminum for this screw-machine job.

As an interesting sidelight, even though these leg caps are gold anodized, the yellow metals were never considered for the job. Delo found that anodized aluminum will retain its bright finish, whereas the yellow metals have to be lacquered and the lacquer soon wears off, leaving a dull unattractive surface.

For the complete story on machining with aluminum, send for a copy of "Machining Aluminum Alloys". Free when requested on business letterhead. Write *Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Ky.*

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

(Continued From Preceding Page)

Faster-Welding Aluminum Lowers Labor Costs For Ballymore Safety Stepladder

The Ballymore Company of Wayne, Pennsylvania, recently announced a complete new line of aluminum Safety Stepladders to complement a steel line previously available. Ballymore says there has been an increasing demand from their agents and customers for safety ladders that are lightweight for easy handling, sanitary for food plants, non-sparking for explosive atmospheres and corrosion resistant for better appearance in every use. Aluminum provides all these advantages.

All-welded construction is featured in the new line of aluminum ladders which are available in seven, 1 to 4 step models. Frames are assembled from ½" IPS 6061-T6 aluminum pipe and 3/16"x1" rectangular 6061-T6 aluminum bar. Steps are formed from 3003-H14 aluminum sheet and have adhesive bonded rubber safety treads. Aluminum welding is done by the "Filler-Arc" method which Ballymore says is considerably faster than its steel welding operations and consequently has reduced labor costs.

Aluminum and welding bring many customer and production advantages to manufacturers of metal products. To help you capitalize on these advantages, Reynolds has prepared a 185 page handbook, "Welding Aluminum". Single copies of this fact-packed book are free when requested on business letterhead. Write to *Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Ky.*

Reynolds Aluminum Atomized Powders Used as Fuel for Welding, Cutting and Scarfing

The insatiable hunger of aluminum for oxygen, and its ability to "forage" oxygen from normally stable oxides, makes it an excellent fuel with numerous industrial applications.

In finely powdered granular form — and in the presence of a suitable source of oxygen — the aluminum is capable of generating intensive heat for short periods of time. It can readily reduce such oxides as iron oxide, chromium oxide, calcium oxide, magnesium oxide and carbon dioxide. This property makes aluminum extremely valuable when used as a combined fuel and reducing agent in thermite welding and other chemical reduction processes.

Under correct conditions, it is possible to mix finely divided aluminum with metallic oxides and then ignite the aluminum. Because of the exothermic nature of the reaction, complete reduction of the metallic oxide can be accomplished without the need for additional heat.

In thermite welding, a mixture of aluminum and iron oxide powders or pellets is ignited. The metallic iron resulting from the reduction of the iron oxide flows into the area to be welded or repaired.

The quick high heat release of aluminum in powder form makes it ideal for cutting and scarfing. Several "guns" have been developed for this purpose. By the use of various types of nozzles, the flame of the burning aluminum can be narrowly focused, for exceptionally high accuracy.

These methods have found wide acceptance in cutting heavy scrap for remelting, for the preparation of slabs and billets from ingots, etc. And they are not limited to metals but will also cut concrete, fire brick and slag, and are said to be an economical means for reconditioning furnaces.

The same general principle applies to the use of aluminum powder in "powder lancing". Materials such as concrete, fire brick and sand and metal incrustations, as well as ferrous and non-ferrous metals and their alloys are easily pierced by powder lancing methods. As an example of the efficiency of these processes, a 12-inch concrete slab was pierced in one minute by using a mixture of aluminum and iron powders in a stream of oxygen.

Photo Courtesy of Linde Air Products Company

Aluminum powder is extensively used in explosives. An oxidizing agent in the explosive mixture causes the aluminum to burn rapidly. The terrifically high temperature produced almost instantaneously from this reaction causes very rapid expansion of the explosive gases, resulting in greater shock.

For complete information on these and many other uses and types of aluminum powders, Reynolds has prepared an 84-page booklet, "Aluminum Powders and Pastes". Single copies are free when requested on your business letterhead. Write to *Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Ky.*

WHAT'S NEW

A Quick Look at New Reynolds Aluminum Products and Applications

Aluminum Foil "Supports" Aircraft Carrier

Reynolds Aluminum foil is now being used by the Navy in the construction of the new 60,000 ton USS Ranger. The foil covers the wooden keel blocks on which the ship's steel hull rests, thus protecting the hull against rust due to moisture in the blocks. This is another dramatic example of the protective powers of aluminum foil—the same foil used in many industrial and commercial packaging applications.

Aluminum Sandwich Panel

Aluminum-faced honeycomb panels in several grades and a wide range of thicknesses and sizes are now manufactured by several firms. These panels are vermin-proof, rustproof, and exceptionally strong for their weight. They are used commonly for large signs and displays, for doors, movable partitions, curtain walls and insulated structures, and for furniture. A list of fabricators of Reynolds Aluminum faced honeycomb panels is available by writing Reynolds at the address below.

Consumers Look For Reynolds Design Seal

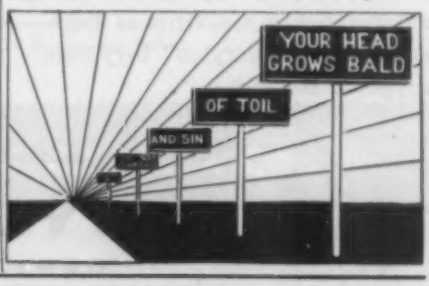
This "Designed In Reynolds Aluminum" seal is familiar in millions of homes, thanks to extensive television advertising. To consumers it means products manufactured with highest quality aluminum—makes buyers out of shoppers. For details on how your company can qualify for this seal, write Reynolds Metals Company at the address below.

Reynolds Publishes Guide to Electric Conductor Accessories

A new manual "A Guide to the Selection of Electric Conductor Accessories" provides information on accessories needed with aluminum wires and cables in constructing overhead transmission and distribution lines. (Reynolds does not make these accessories, merely lists them for your use.) For free copy, send to Reynolds at the address below.

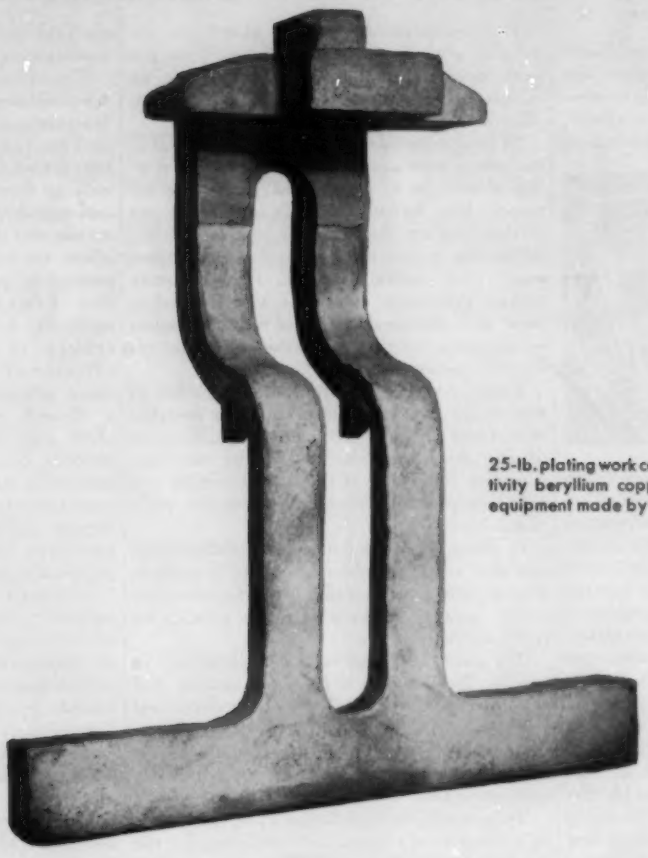
Reynolds Aluminum Used for Shave Creme Jingle Signs

Reynolds Aluminum .006" thick sheet in 1235-H18 alloy and temper is now being used for the familiar roadside shave creme signs. The sheets are mill cut to correct size. After painting they are shipped to sign locations, where they are stapled to permanent boards. Previously 1" lumber boards had to be returned to the Minneapolis office for yearly repainting. Now fresh aluminum sign facings are sent out once a year with an anticipated savings of $25,000 in freight and handling charges. In addition, old discarded sign facings have a definite resale value as scrap.



FOR COMPLETE INFORMATION ON THESE OR ANY OTHER REYNOLDS ALUMINUM PRODUCT, write to Reynolds Metals Company, P.O. Box 1800-HR, Louisville 1, Kentucky

WHEN PARTS ARE CAST FOR A TOUGH ROLE



25-lb. plating work carrier cast in high-conductivity beryllium copper and used in plating equipment made by The Udylite Corporation.

THEY'RE MADE OF BERYLCO® BERYLLIUM COPPER

The increased amperage called for in modern plating equipment demands higher conductivity in this casting—a contact which rides on a copper bus bar and transmits current from the bar to the plating tanks. Various materials used in the past, although they had the required wear resistance, lacked the conductivity for this application. To get around the problem, engineers considered brazing a strip of high-conductivity "Berylco" beryllium copper to the part.

Our engineers recommended that instead the whole part be cast in "Berylco." The solution was ideal. "Berylco" not only combines high conductivity with high strength and remarkable wear resistance, but is also a very good casting alloy. Pouring temperatures are low, fluidity is excellent, and needed detail can be sharply reproduced. Most important, cost is competitive.

What do you expect an alloy to deliver? Fatigue resistance? Corrosion resistance? Strength? Conductivity? Elasticity? Workability? "Berylco" beryllium copper fills these and many other roles as no other alloy can. Write any of the offices listed below for free testing samples or technical assistance.

DOZENS OF APPLICATIONS

for "Berylco" beryllium copper are discussed in detail in this informative 32-page booklet. Send for your free copy today.

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type 412

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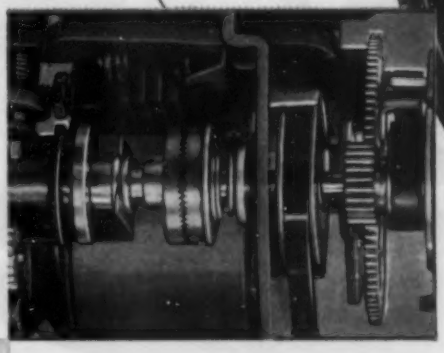

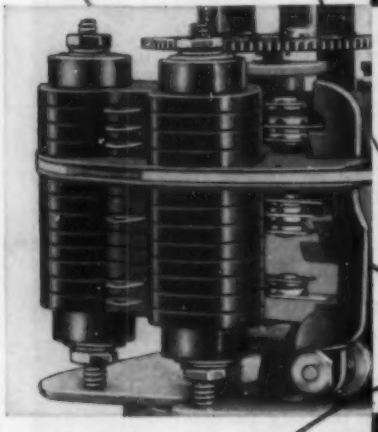

NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

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Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

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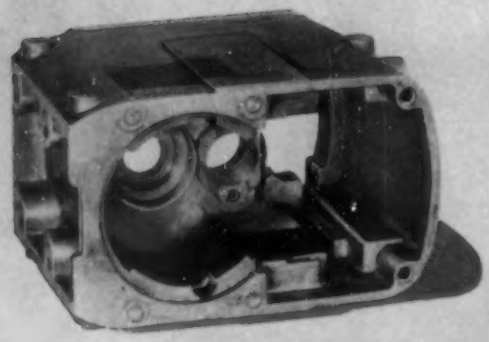
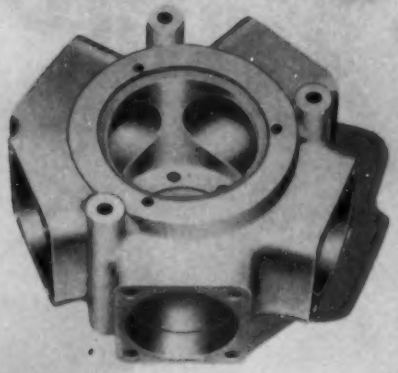
ZINC DIE CASTINGS

complete—in one casting operation



ALUMINUM DIE CASTINGS

complete—in one casting operation



MODERN METHODS to cut component parts costs by PARKER

POWDERED METAL PARTS

complete—in one pressing operation

A sure way to cut your component parts costs is to eliminate production operations. Parker die castings and powdered metal parts save money by reducing—in many cases eliminating—costly machining operations and scrap loss. The parts shown here are typical examples of Parker's skill in these modern production methods. You'll find it worthwhile to check on the cost and design advantages of Parker die castings and powdered metal parts. Just call the nearest Parker Sales Engineer listed here or write the factory direct.

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ALUMINUM and ZINC DIE CASTINGS
POWDERED METAL PARTS

5 WATERMAN CONTROLS

For accuracy - dependability - safety - low maintenance cost

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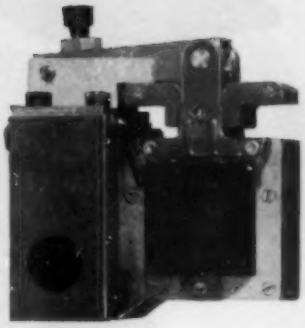
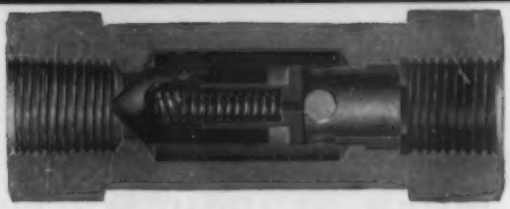


SOLENOID VALVES for working pressures to 3000 psi. Designed for remote control of hydraulic systems, and handling non-corrosive fluids. Poppet construction eliminates leakage. Impregnated coils are oil and moisture resistant. Avaliable in 100-220 Volt A.C.



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CHECK VALVES—one piece construction—no welds to crack. Nylon Poppet assures leak-proof service. Light weight aluminum body. Low pressure drop. Available in 3/8", 1/2", 3/4" and 1" NPT line sizes.

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Operating pressures to 3000 psi. 10 micron filtration. Replaceable elements. Available in 3/8" and 3/4" NPT.

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FULL RANGE ADJUSTABLE FLOW REGULATORS from 0.5 GPM to 20 GPM. All Waterman Flow Regulators maintain a constant rate of flow regardless of work resistance or pressure fluctuations.

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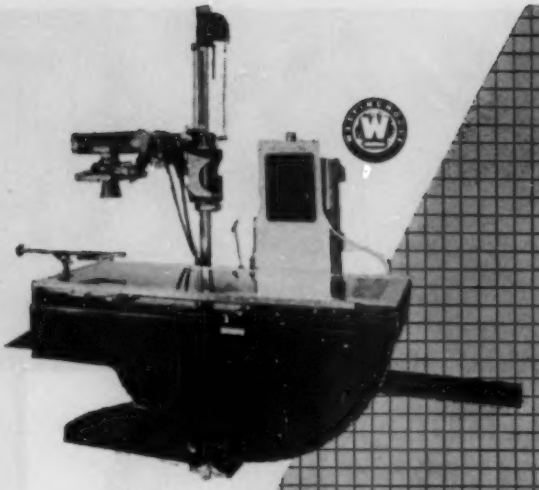
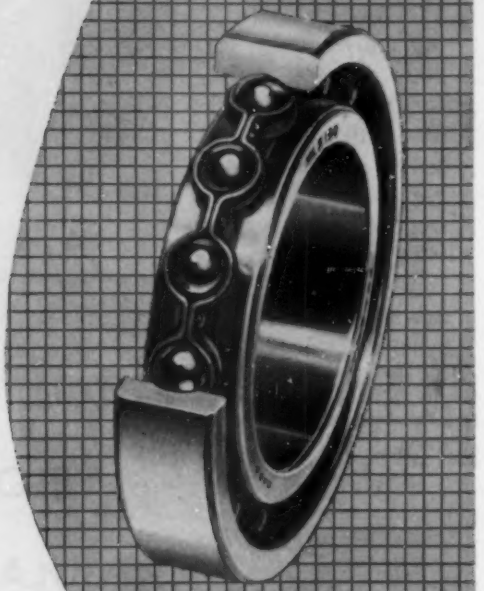
X-ray tables require a precision all their own, for smooth, easy positioning. And, if you were to X-ray this Westinghouse Duoflex motor-driven table, you would see Federal Ball Bearings quietly at work here, too.



so much of industry *turns* on FEDERAL ball bearings



X-rays or escalators—hum of motors or heft of hoists—in the clinic or machine shop—Federal Ball Bearings do their quiet, anti-friction job. In your office, plant or home, you'll probably find some of the hundreds of types and 12,000 sizes produced by this 50-year-old manufacturer of ball bearings exclusively.

When Federal Ball Bearings are a part of so many things you *use*, shouldn't they be a part of the things you *make*?

175 pages, chock full of data about ball bearings are yours for the asking in FEDERAL's new catalog. Just drop us a line for your copy.

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, N. Y.

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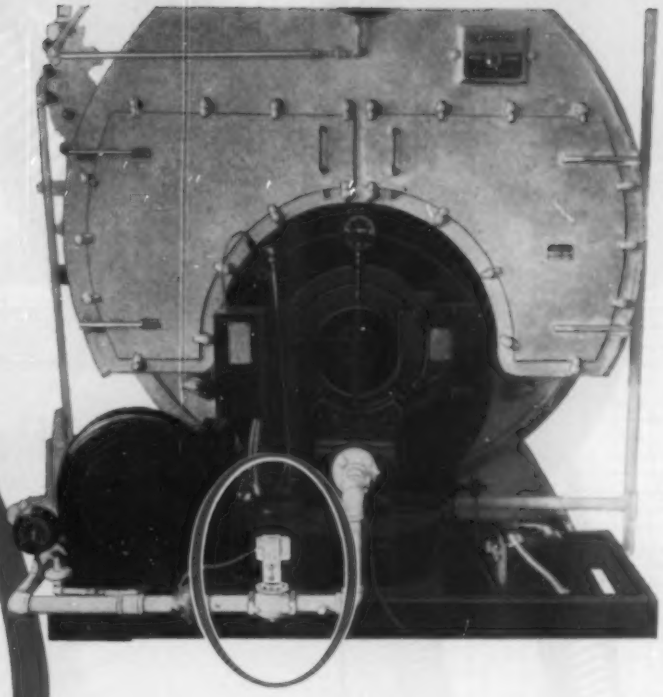
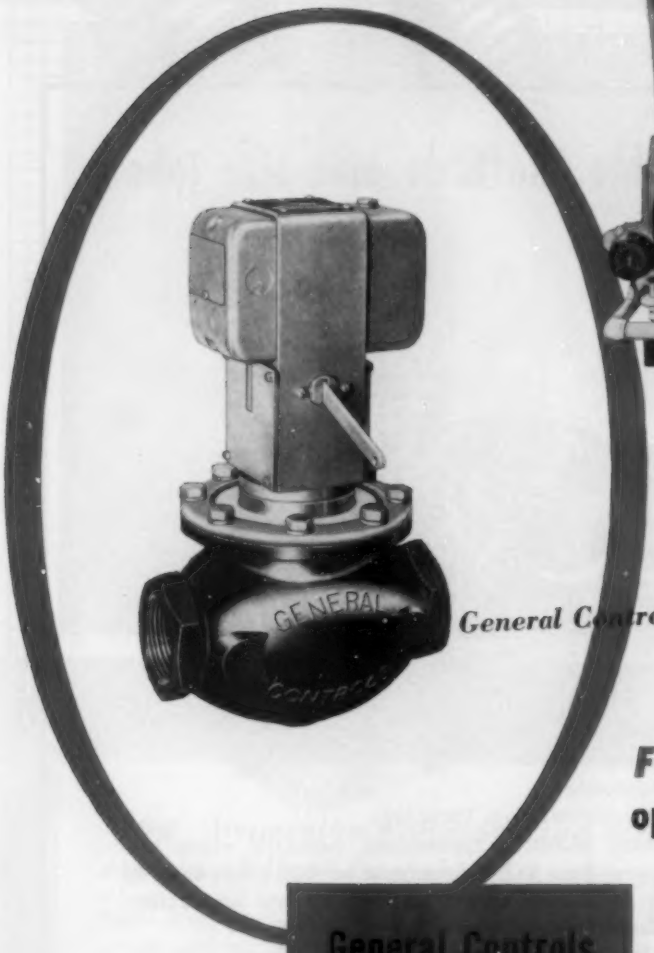
Husky electric hoists—capable of lifting and conveying up to 15 ton loads put a strain on bearings, too. In these mechanical "strong men", too, you'll find Federal Ball Bearings.

Federal BALL BEARINGS One of America's Largest Ball Bearing Manufacturers

Factory Mutual and Underwriters Laboratory Approved. Fast-Closing... Fast or Slow Opening to fit any combustion requirements. Optional Accessories for Special Needs.





General Controls' new H-series Hydramotor gas fuel valves

FAST-CLOSING GAS VALVE
opens the way to Better Boiler Control

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HYDRAMOTOR
Gas Fuel Valves

This new successor to General Controls' famous G-2 Hydramotor valve does even a better job... closing in one second or less in no-lag response to sensitive limit control commands (or power failure). Positive spring action guarantees this—with General Controls' single seat design to assure *really* tight shutoff, and electro-hydraulic action for ample opening power. All parts inside the cast iron body are aluminum or stainless steel, good for any gas. Overported body provides maximum capacity at minimum cost. Make it a policy to insure premium performance on every boiler job with General Controls' new H-series Hydramotors. Write for catalog with full details today.

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Flexible Shafts do man-size jobs

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to see large-size S.S.White
flexible shafts driving concrete
vibrators such as the one shown above. These big, strong shafts have many industrial applications, especially where substantial amounts of power have to be transmitted between two points. In addition to providing an unusual degree of flexibility and adaptability, these large-size flexible shafts, available up to ¾" in diameter, are built to last longer and perform better.

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Flexible shaft information for you...
Bulletin 5306 has basic information and data on flexible shaft selection and application. Send for a copy. Address Dept. D

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'dag' dispersion stops scoring during run-in of light-weight compressor

Early in the production phase of a new light-weight aluminum compressor for the high-pressure pneumatic systems of aircraft, engineers of Walter Kidde & Company, Inc., Belleville, N. J. realized that special attention would have to be given to lubrication during run-in of the units. Tests of initial models showed that since oil film didn't have a chance to build up during the first few moments of run-in, pistons and cylinder walls were scored. This resulted in a high reject rate and expensive refinishing operations on first-stage pistons.

Kidde engineers have solved the problem by spraying finished pistons with undiluted **'dag'** Dispersion No. 213 before assembly of the units. The microscopically fine particles of colloidal graphite, dispersed in epoxy resin, form a tenacious bond with the metal surface after baking—provide a *dry lubricating film* that will not rub off during assembly and which prevents scoring and seizure during compressor run-in.

There are many other ways in which the dry-film lubrication provided by **'dag'** dispersions can help in the design and operation of all sorts of mechanisms, from toasters to turbines. Write for full information on **'dag'** Colloidal Dispersions for Dry-Film Lubrication, Bulletin No. 438-Q8.

Dispersions of molybdenum disulfide are available in various carriers. We are also equipped to do custom dispersing of solids in a wide variety of carriers.

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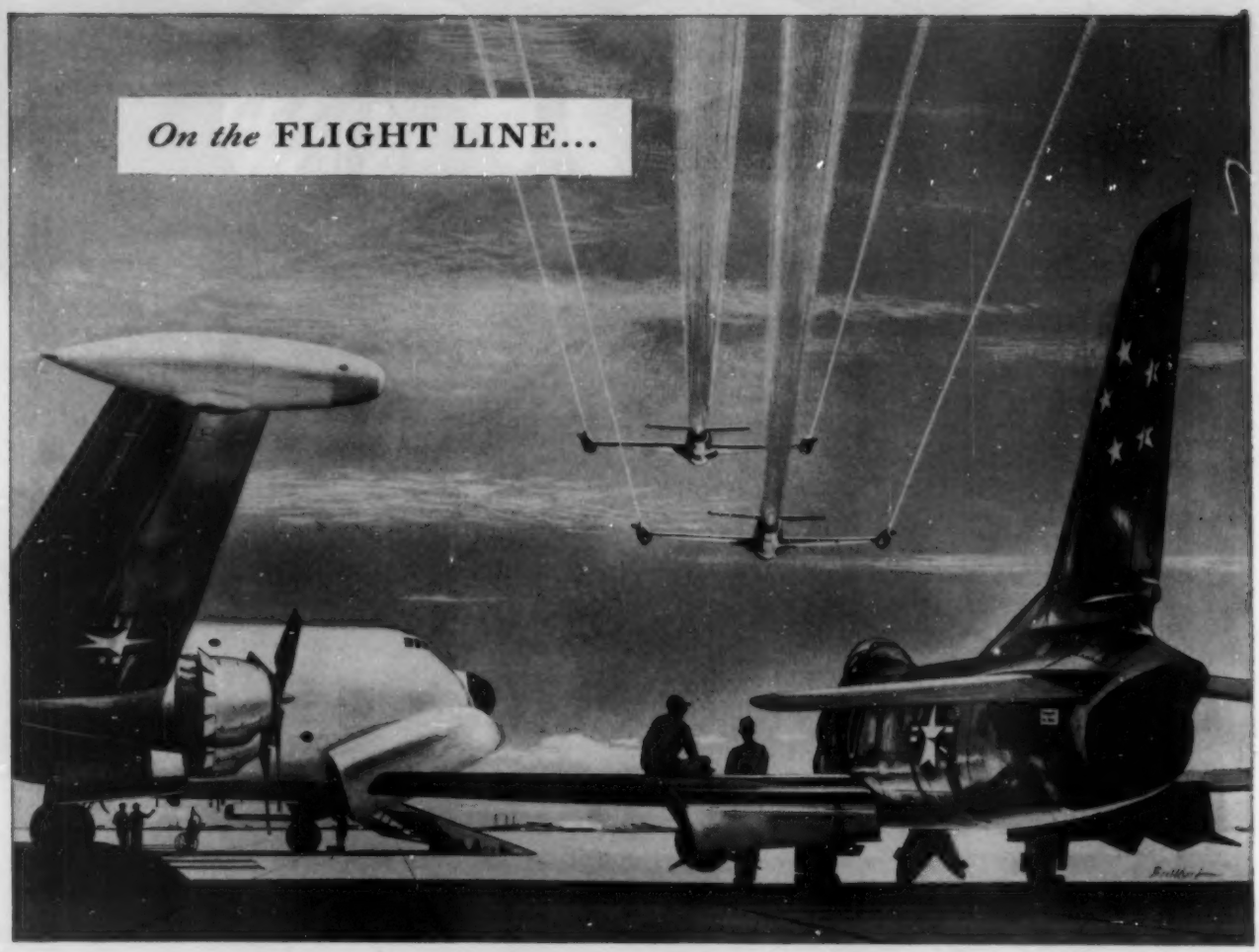
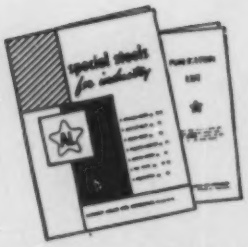
use 'dag' dry films for trouble-free lubrication



FIRST COST *can be the* LEAST COST

if it's the LAST COST



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Make it BETTER-and LONGER LASTING-with

AL Stainless Steel

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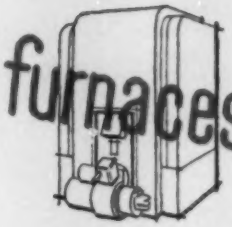
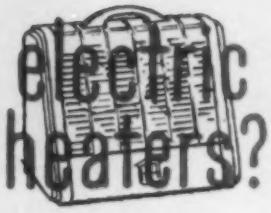
Want to eliminate noise or vibration in:

LORD couplings transmit torque evenly. Tub mountings dampen vibration and compensate for irregular loading or misalignment.



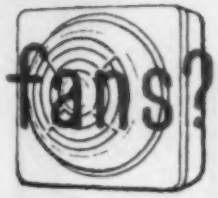
Furnaces operate quietly with fan hubs, blower mountings and base mountings by LORD.



Heater fans give hushed operation and are less distracting when equipped with LORD bonded-rubber fan hubs.

LORD mountings maintain alignment, eliminate vertical "bounce" and transmit even pressure to sanding plate.

Bonded-rubber fan hubs, pillow-block bearings, idler and drive wheels for smooth, noiseless performance.



Blade vibration and misalignment eliminated with LORD bonded-rubber fan hubs.

LORD mountings assure accurate seating of drive motor and absorb blade shock for smoother operation.

Bonded-rubber idler wheels eliminate turntable "rumble" — maintain the highest performance standards.

Motors and/or compressors mounted by LORD and fans equipped with bonded-rubber hubs team up to give cushioned, silent operation.

LORD couplings and mountings absorb cutter shock, assure positive positioning and deliver impulse-free power.

Compressor motor vibration and noise isolated with bonded-rubber motor mountings.

LORD idler and drive wheels prevent "wow" — assure "high-fidelity" output.

Noise and vibration can seriously affect the market preference for your product. Modern household appliances have greater sales appeal when equipped with these LORD "silent salesmen".

Find out how LORD bonded-rubber products can improve the performance of your product. LORD has over 30 years of experience in furnishing the best in vibration control and shock resistance to some of industry's most successful appliances. LORD Field Engineers are located in major industrial centers. Call, or write to the LORD office nearest you!

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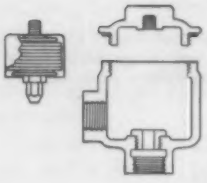
STEAM TRAP

Quality

Nicholson quality . . . that gives you the extra strength, extra capacity, extra *stamina* required for severest steam-using equipment service. Nicholson quality pays off, when it comes to discharging condensate and air from steam lines . . . most efficiently, dependably, economically.

Just 3 quality parts—thermostatic bellows, body, cap. Simple, positive action. Won't leak!



- **Powerful valve action—big husky bellows.**
- **Positive shut-off—finely ground valve and seat.**
- **High capacity—large diameter orifice.**
- **Rigidly tested—on actual steam lines.**

When less than best won't do, specify Nicholson. Send for *Catalog 953*.

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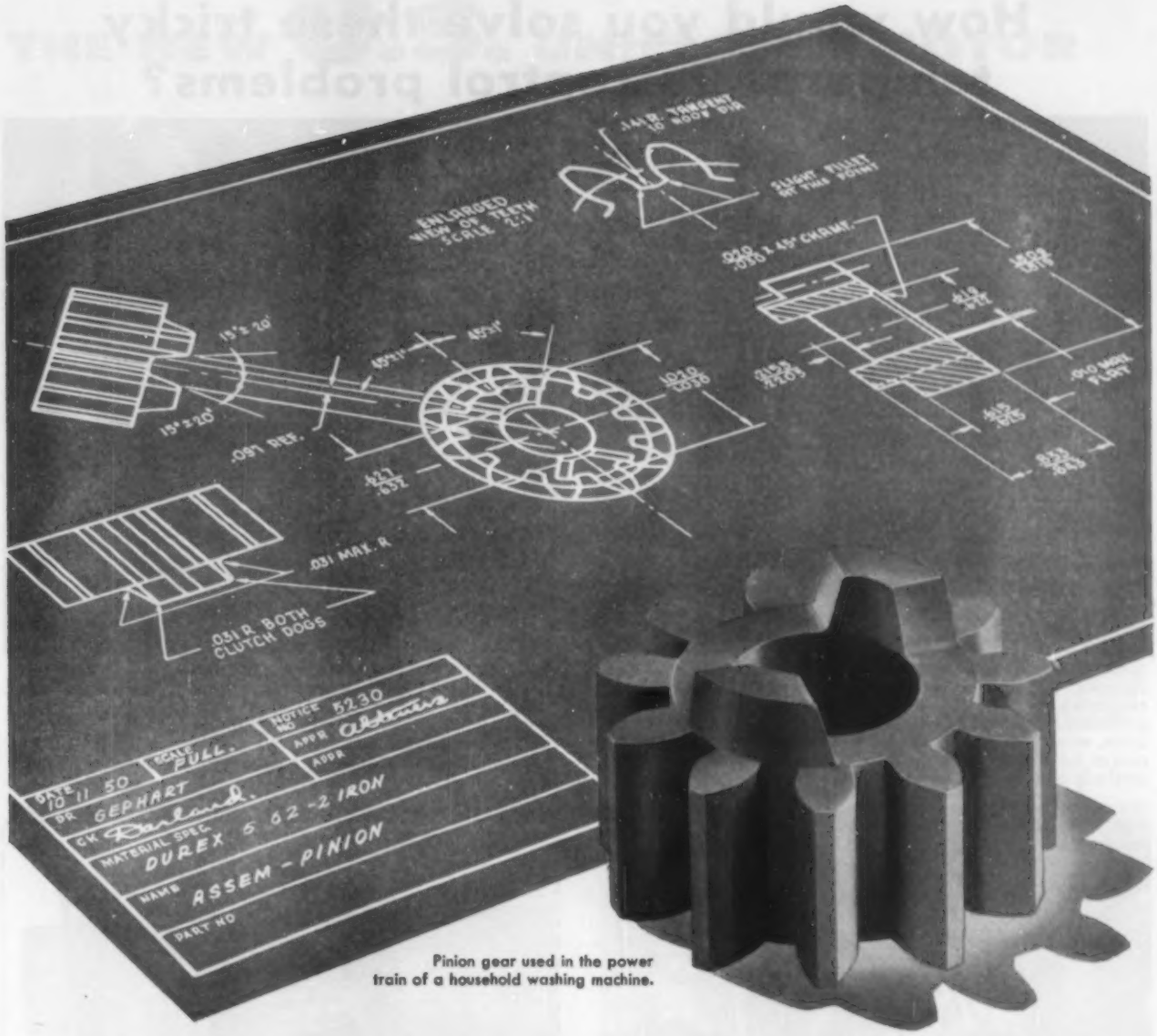


Pinion gear used in the power train of a household washing machine.

MORAINE METAL POWDER PARTS SOLVE MANY PRODUCTION PROBLEMS

Here you see a complex design that is being mass-produced today by metal powder techniques *with important savings in cost.*

The print in the background indicates the intricacy of the design, while the photograph in the foreground shows the part ready to be assembled into the final mechanism. And from raw material to what you see here took only *one press operation!*

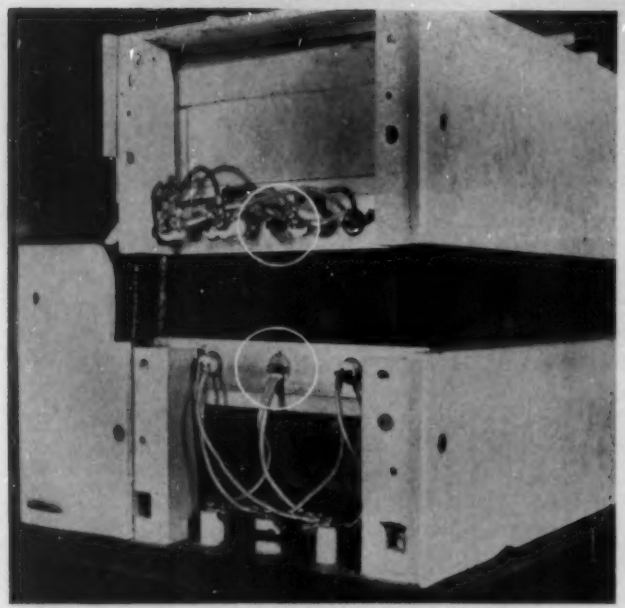
This demonstrates what has come to be expected through cooperation between customer and Moraine.

Moraine's experience with metal powder is called upon almost daily to resolve complex designs into economical production jobs—just as Moraine almost daily contributes to modern industry by improving product performance and lowering costs.

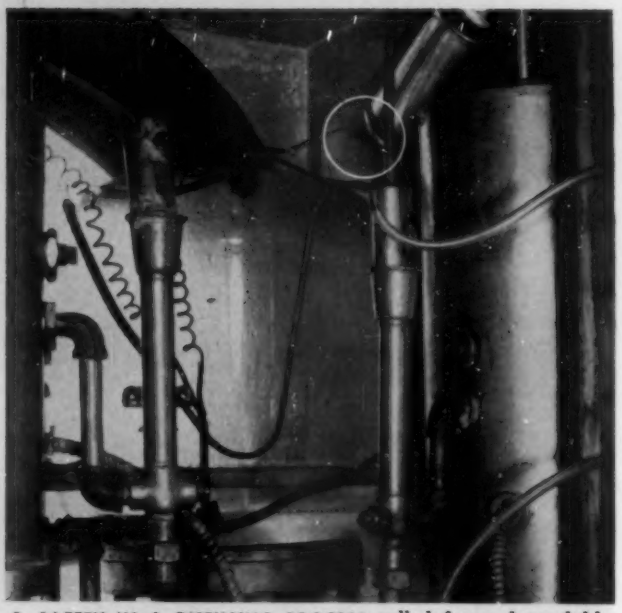
moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

METAL POWDER PARTS

How would you solve these tricky temperature control problems?

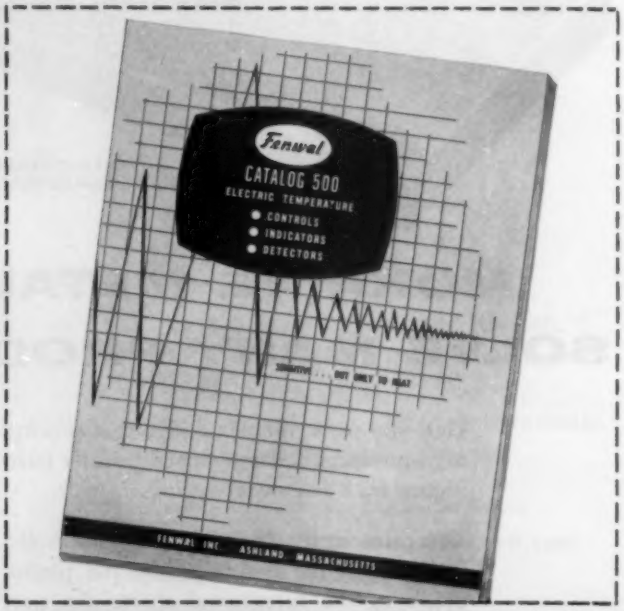


1. CONTROLLING HIGH FREQUENCY HEATING. In this vulcanizing patch press, precise temperature control of the platens was required to prevent loss of electronic heat generated within the processed material. Fenwal's solution was two THERMOSWITCH® units, set at 400F, mounted on the platens. Result: a production rate of 3,000 patches per hour, compared to ordinary hot press methods of 30 per hour.



2. SAFETY IN A DISTILLING PROCESS called for a dependable failure alarm. A Fenwal THERMOSWITCH unit in the condenser's safety vent solved the problem. Now, should the cold water supply fail, steam blowing through the condenser tubes will hit the THERMOSWITCH unit. This control, set at 120F, will then open, shutting off the electric heaters and sounding a continuous alarm.

3. PROTECTING PRODUCTS. In this shoe lining smoother, the problem was twofold: to use the fewest possible thermostats; provide close temperature control in order to prevent burning of shoe leather. Fenwal's solution: a single adjustable THERMOSWITCH unit, mounted on one ironer and controlling two ironers. This halved the number of thermostats indicated, while providing precision temperature control.



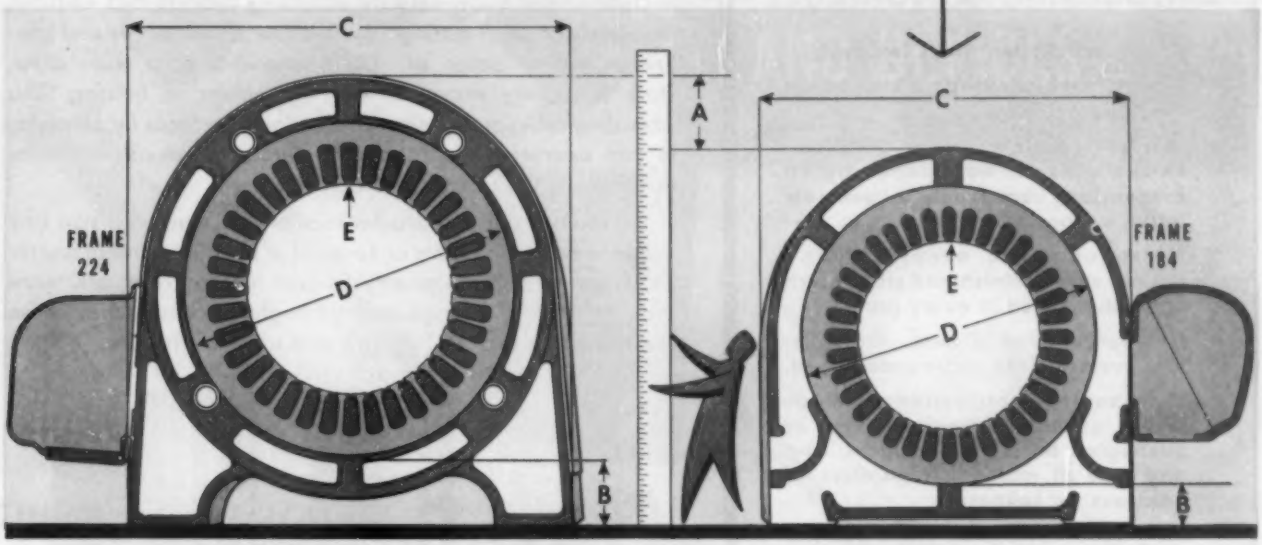
4. SEND FOR NEW CATALOG, just off the press. It describes Fenwal's complete line of THERMOSWITCH units and new indicating controllers for industrial applications. Fenwal engineers are always glad to help on any of your temperature control problems. Write **Fenwal Incorporated, 210 Pleasant St., Ashland, Massachusetts.**

Fenwal **THERMOSWITCH®**

Controls Temperature — Precisely

THE NEW U.S. UNICLOSED MOTOR

saves 46% in space*



PREVIOUS DESIGN — NEW DESIGN

COMPARISON

A — Over-all height reduced
B — Stator closer to mounting surface
C — Over-all width reduced
D — Approx. same punching O. D.
E — Same number of slots

* EXAMPLE — 2 h.p., 4-pole
Previous 224 Frame — 1663 cu. in.
New 184 Frame — 891 cu. in.
SAVING — 772 cu. in. or 46%

More Horsepower per cubic inch

Saving in space of 46% for the 2 h.p. size, in comparison with previous NEMA dimensions, is typical of the ratings in the new U. S. Type H Uniclosed motor. Improvement of insulation, advanced electrical design, closer tolerances, all contribute to development of maximum horsepower within the least cubical space. Many other exclusive U. S. features, such as asbestos-protected windings, Lubriflush transverse lubrication, solid cast-iron frame and normalized castings, also add longer life and more efficient power.

Mail Coupon for informative full-color 12-page Type H Bulletin

U. S. ELECTRICAL MOTORS, INC. PRE-10
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Compare These Microhoning Advantages

- Rapid and efficient stock removal.
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- Microgeometric accuracy—any desired surface finish and cross-hatch angle duplicated in every part.
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- Microhoning applications include tapers, spheres, splines, tandem or interrupted bores, flat surfaces, and any type of material, regardless of hardness (or softness).
- No practical limitation on part length and diameter.
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- Automatic size control.
- Readily adapted to automation.
- Eliminates tool dressing time and cost.
- Location of bores is undisturbed.
- Float principle and low speeds assure minimum maintenance.
- Backed by over 26 years of engineering and service experience.

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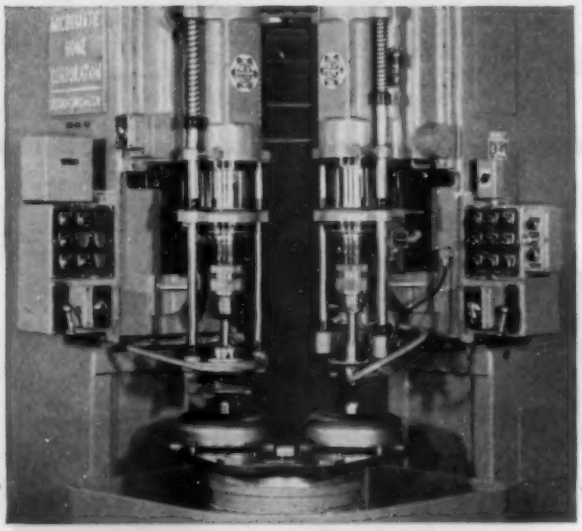
Microhoning is a low-velocity abrading process that employs thousands of small cutting tips. Because simultaneous and continuous cutting action of tips is spread over a wide area, stock is rapidly removed with a minimum of heating. This abrading technique generates functional surfaces ***by obtaining in one operation the required tolerances, specifications, or condition*** of the surface characteristics.

Included in these characteristics are: dimensional size (the distance between points or faces of a part, e.g., the diameter of a bore); macrogeometry (waves whose crests are more than 1/32" apart); microgeometry (roughness or scratches whose crests are less than 1/32" apart); and surface structure.



Microhoning . . . Example Application

Microhoning both I.D. and O.D. of the hub of a transmission torus cover to generate geometric accuracy and a surface finish of 10 microinches.

O.D.—*2.375", approx. 1" long, blind end*
I.D. —*2.125" x .280" long*
58-60 Rockwell "C"
Stock removal: *.001" to .002"*
Surface finish: *10 microinches*
Production: *180 per hour, gross.*

***MICROHONING = Stock Removal + Geometry + Size Control + Surface Finish**

Movies describing various machining processes and the generation of functional surfaces are available for group meetings. For literature or further information on films, write to:

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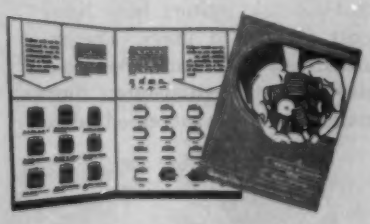

HERE'S HELPFUL INFORMATION
This 32 page catalog covers basic bellows engineering, conversion tables, metals available and other bellows data. Use the handy coupon for your free copy.

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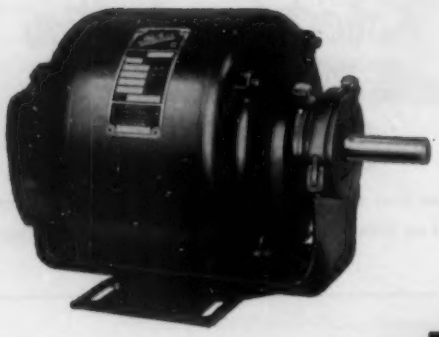
One Satisfied Customer tells another...



When women get together, appliances are bound to get into the conversation before long. Then one of a manufacturer's best salesmen—the satisfied customer—can really do a job for him. When the talk is about *Packard*-powered appliances, the job is done with extra enthusiasm—from sheer satisfaction.

For over 38 years Packard Electric motors have been giving dependable, low-cost service to users. The appliance maker who standardizes on Packard fractional horsepower motors benefits from the satisfaction they give, from enhanced reputation and from increased sales.

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General Motors,
Warren, Ohio

Bundy-engineered design gives customer better function with lower part cost

Here's another example showing how expert Bundy engineers can help with *your* design problem

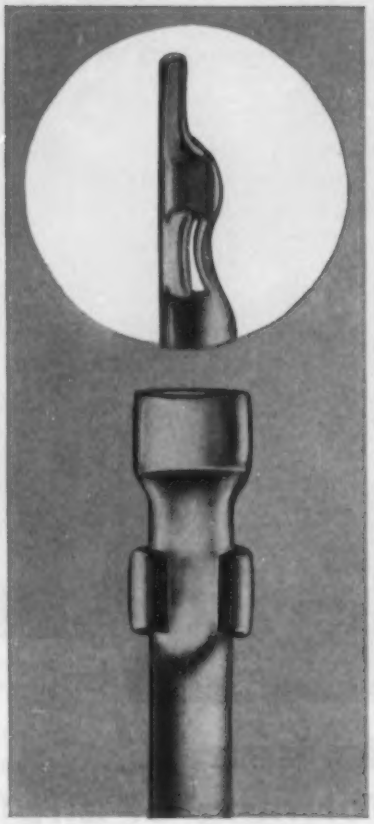
Product designers the world over bring their tubing problems to Bundy. Here's why: Bundy is a prime source for sound information and ideas — not only on gasoline vent tubes, but on any other tubing application.

Shown at right is an example of the help you get when you present your tubing problems to Bundy. When you call on Bundy's staff of engineers at the design stage of your product, you can be sure we'll come up with a practical, workable solution to your problem.

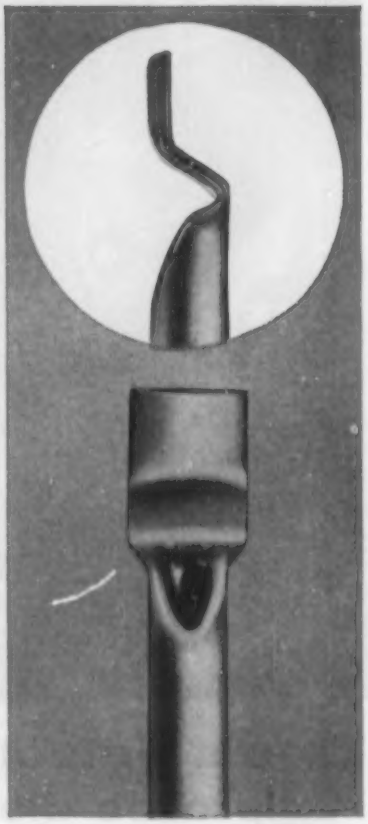
Get to know the quality of Bundyweld Tubing. Bundyweld is the only tubing that is double-walled from a single metal strip, copper-bonded throughout 360° of wall contact. It is strong, lightweight; has high tensile and fatigue strength. It is leakproof, and has high thermal conductivity. The standard of the refrigeration industry, Bundyweld is *used in 95% of today's cars, in an average of 20 applications each!*

The assistance we have given others, we can give you. Call, wire, or write Bundy, today!

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



Problem: Customer submitted specification for vent tube, as shown above, for use inside gasoline filler tube. Problem was to remove the possibility of gasoline entering two side vents as gas tank was filled. The Bundy engineers showed customer the way to big fabrication savings.



Solution: Improved design suggested by Bundy engineers completely protects vent from gasoline entry by baffle deflection. Moreover, this part requires just two simple operations: one to flatten end and pierce tube simultaneously, the other to put a double bend in flattened end.

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

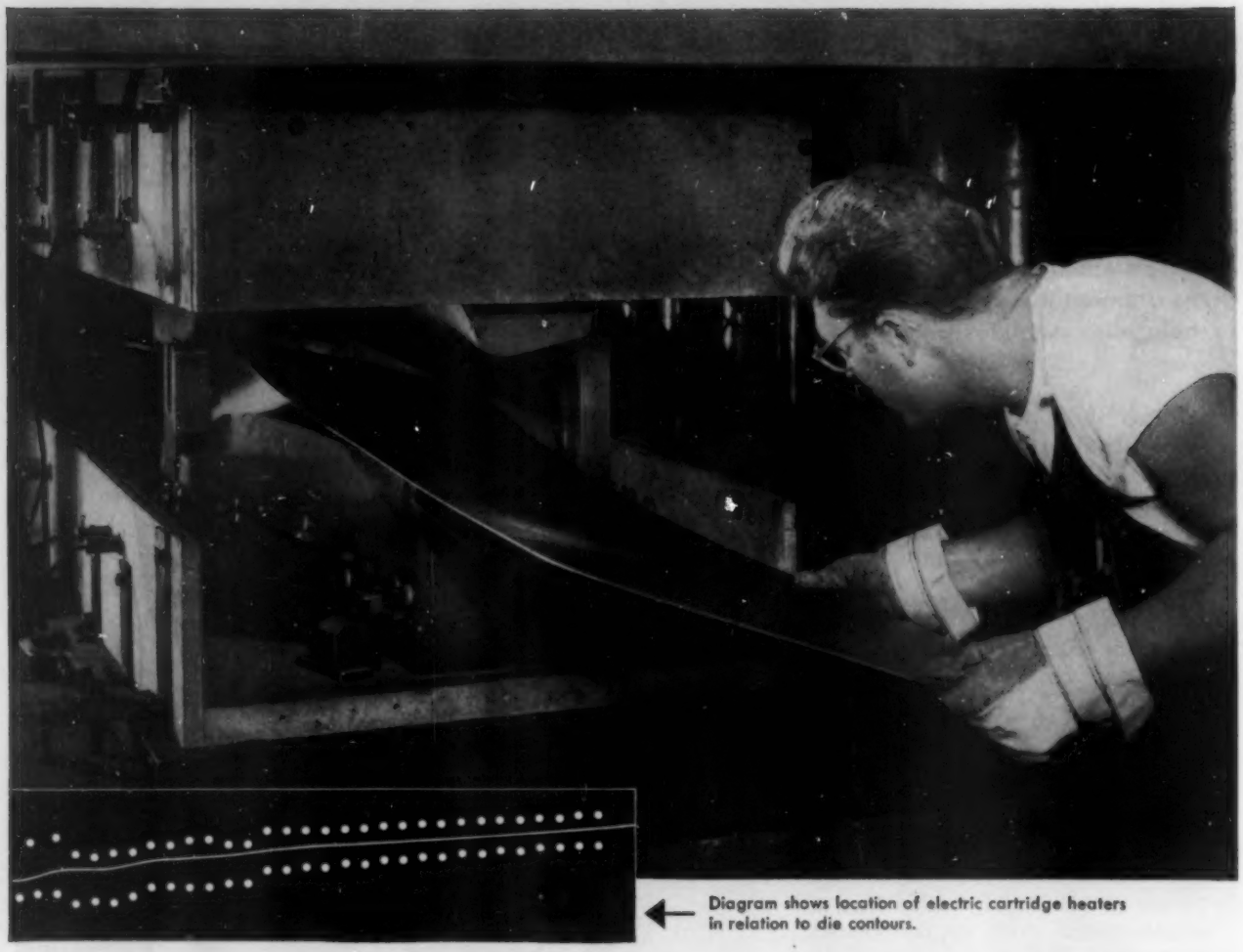


Diagram shows location of electric cartridge heaters in relation to die contours.

precise electric heat ... improves die-forming of airplane propellers

In the manufacturing of hollow steel propeller blades, by this company, a ribbed thrust face and a matching camber sheet are furnace-brazed together. Before brazing, however, the camber sheet must be die-formed to exactly fit the thrust side of the blade.

It was found that a *heated* die-forming press produced better shaped camber sheets and relieved mechanical stresses. But the temperature had to be closely controlled at a minimum of 900°F in both top and bottom halves of the die. Only electric heat could meet these difficult conditions.

So sixty-three Chromalox Electric Cartridge Heaters, of selected lengths and wattages—totaling 97,350 watts—were inserted at regular intervals in the sides of the die, as shown in the diagram. Each half of the die was divided into six heat zones . . . with a thermocouple in each zone connected to a common control panel. Heat is generated in the right amounts *within the die.*

Results are uniform, controlled heat. Relatively low initial installation cost. Cool working conditions around the press. Consistent production. And six similar sets of dies, heated by Chromalox Electric Cartridge Heaters, now in operation in this plant.

This problem-solution-result approach has enabled us to help many manufacturers produce better, faster, at lower cost.

Always available to you are our research, engineering, design, and modern manufacturing facilities. The world's largest factory stock of industrial electric heaters plus local stocks at strategic points. And a 33-city nationwide sales-engineering service.

Let us know your problem for controlled heat and we'll go all out to help you find the right answer—electrically.

A-4436

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Send for your copy of F1550—
"101 Ways to apply Electric Heat."

Your latest reference to better production

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EXTRUDED SECTIONS
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. . . tailor made
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1. YOUR section is preformed to the cross section of the part you wish to produce. The range of sections is practically unlimited.
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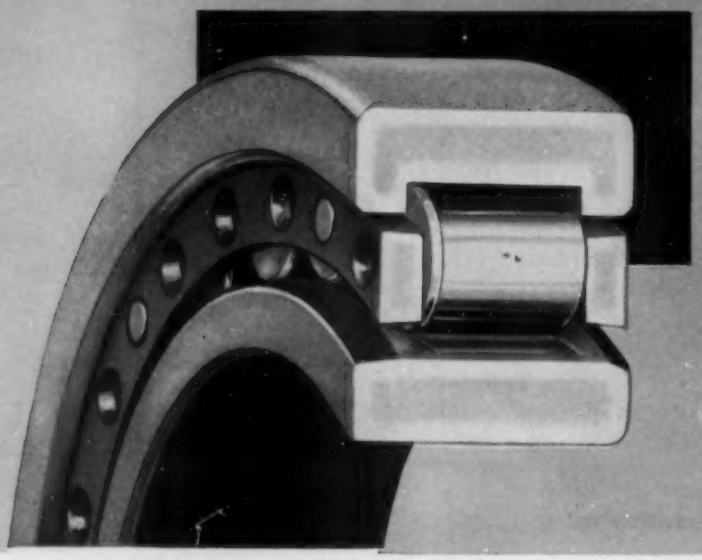
Bower straight roller bearings carry maximum loads!



TWO-LIP RACE INCREASES RIGIDITY— IMPROVES ROLL ALIGNMENT

Examine the cutaway view of the Bower straight roller bearing, shown above. It is important to note particularly the two parallel lips made integral with the outer race. These lips or shoulders provide a rigid, durable construction—keeping the rolls in proper alignment.

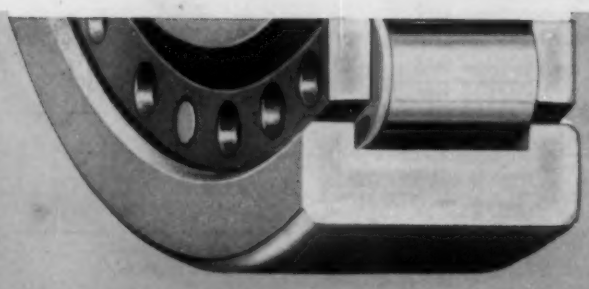
Built of highest quality materials, Bower straight roller bearings have proved themselves capable of standing up day in and day out under maximum loads and the most rugged conditions—with virtually no maintenance whatsoever. They are used extensively in such fields as automotive, earthmoving, farm equipment and heavy machine tool. For the aircraft industry, Bower builds straight roller bearings—especially designed for high-speed, high-temperature operation—which are used by virtually every producer of jet engines.

Whatever you manufacture, you'll build a better product with Bower roller bearings. Write to Bower today. A Bower engineer will give you full details of the complete Bower line.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.

BOWER

ROLLER BEARINGS



A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

You can simplify purchasing . . . improve design . . . speed production

with improved C-D-F DILECTO® laminates

Only C-D-F, the Continental-Diamond Fibre Company, makes Dilecto laminated plastic, just as only Cadillac makes a Cadillac. Dilecto is 50 different materials with more combinations and variations in desired properties than we can tell you here.

But Dilecto has three important qualities that you should think about if you buy, design, or machine laminated plastics.

DILECTO HAS HIGH MECHANICAL STRENGTH

Mechanical strength is frequently an important determining factor in the selection of an insulating material. Insulating parts used in large electrical power equipment are frequently bulky. The high mechanical strength of Dilecto helps reduce size-dimensions of insulating parts without danger of failure. Instruments, meters and small motors frequently require very small insulating parts which must withstand comparatively large mechanical stresses. Insulation for use in high frequency circuits should have a minimum bulk factor for minimum dielectric losses. Dilecto fulfills these requirements with a combination of high mechanical strength and low loss factor, characteristic of the better C-D-F electrical grades.

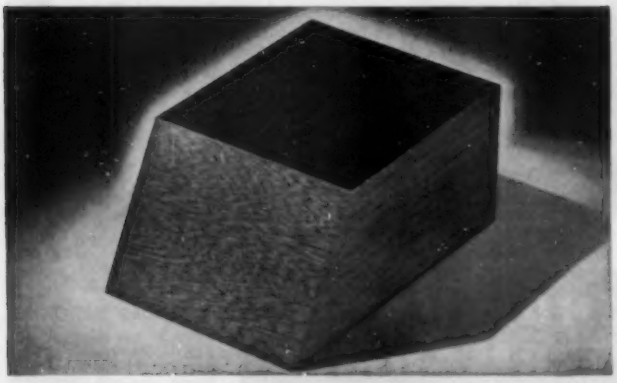
So C-D-F selects for your Dilecto insulation grade the correct, highest quality base material, paper, cotton, nylon, glass. These are used in combination with improved penetrating resins: Improved Phenolic, New Melamine, New Silicone, New Teflon, all synthetic, well polymerized resins.

Both the base and the resin are good insulators by themselves. But C-D-F sells them to you in an improved, practical form . . . Dilecto. Uniform sheets, tight tubes, strong rods, close tolerance machined and formed specialties, high bond strength metal clads.

Why does Dilecto combine so well mechanical strength with dielectric strength and dimensional stability? Because Dilecto is almost homogeneous, a true blend of resin and base.

DILECTO IS ALMOST HOMOGENEOUS

A poor laminate absorbs moisture at its edges, loses its insulating properties fast. Entrapped moisture and other volatiles within the cured structure causes inconsistent dielectric strength, with ultimate puncture and breakdown.



Punch press and bench saw operators know how much time and material is saved when the laminated plastic is *uniform* and *homogeneous* in nature like Dilecto.

DILECTO IS IMPROVED

Yes, C-D-F Dilecto is an improved laminated plastic, due to high standards and advances in resin and manufacturing techniques. It is watched by skilled workers in our modern plants, checked against rigid standards . . . C-D-F standards . . . by our quality control people. It is easy to machine, and the C-D-F shops are doing a booming business in specialties.

Table I—Typical Improved Phenolic Laminates

Commercial designation[a]	Resin	Filler	Improved properties	Improvement due to:
MEC-5	Phenolic	Nylon fabric	Insulation resistance; moisture resistance	Filler
XXHV-2[b]	Phenolic	Paper	High dielectric strength parallel to laminations	Resin and manufacturing technique
CRD	Phenolic	Cotton mat	Better machining	Filler
XXXP-26[b]	Phenolic	Paper	Insulation resistance; moisture resistance	Resin and manufacturing technique
C-92	Xylenol[c]	Cotton fabric	Alkali resistance	Resin
CF	Modified phenolic	Cotton fabric	Postforming	Resin

[a] All grades are Continental-Diamond Fibre Company.
[b] Resins have improved penetrating properties and the manufacturing techniques use these properties to provide better impregnation of the filler. Since thorough impregnation eliminates entrapped moisture and air, greater moisture resistance and better dielectric properties are attained. Manufacturing techniques also provide suitable temperature control during the curing stage to assure uniform quality and optimum property values in the finished laminate.
[c] Xylenol is essentially a dimethyl phenol.

—from Electrical Manufacturing Article "Wider Design Opportunities with the NEW Phenolics", Part II.

The next time you think of laminated plastics, the name to remember is C-D-F Dilecto. The improved, high strength, uniform material that makes insulation buying and using more a science, less a puzzle. New grades, new applications, new savings are just part of the Dilecto success story. Look up the facts in Sweet's Design File, or write for catalog. Send us your blueprint for quotation . . . tell us your design dream . . . C-D-F wants to work with you.

CDF *Continental-Diamond Fibre*

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 40, DELAWARE

How Indiana-designed Permanent Magnets

made a loud-speaker lighter . . a nuclear resonance research unit more powerful!

Here are two case histories showing interesting and somewhat unusual applications of Indiana Permanent Magnets . . one tells the story of a tiny 1/10 ounce magnet, the other the story of a massive ½ ton magnet.

Each application called for creative and imaginative thinking . . the same kind of original engineering and design thinking that is an important part of every Indiana Permanent Magnet.

Because Indiana Steel Products Company believes so strongly in the vital importance of creative and originative magnet design, it maintains the world's largest engineering staff devoted solely to the design and application of permanent magnets.

This specialized service is available to original equipment manufacturers. Indiana engineers, with more than 45 years experience in designing permanent magnets for some 40,000 applications, will welcome the opportunity to work with you in the development of *your* permanent magnet designs. Write for detailed information and a copy of *Engineering Design Manual 4-C-10.*

1/10-OUNCE PERMANENT MAGNET . . This headphone set, which includes a loud-speaker only 13/16" in diameter, is used with secretarial transcribing machines, group-hearing systems, for hotel and hospital radios, in beauty salons, dental offices, broadcasting studios, airports, etc.

The headset had to be light, which called for an exceptionally light permanent magnet of high energy. Level or sound quality could not be sacrificed. The manufacturer working with Indiana design engineers used Hyflux Alnico V. Result: Indiana Permanent Magnets that weigh only 1/10 ounce.

½-TON PERMANENT MAGNET . . Here is one of the world's largest permanent magnet assemblies. Used in nuclear resonance research, it contains over 1,000 pounds of Indiana Hyflux Alnico V, and produces a magnetic field of 6,750 gausses in the air gap.

It provides an extremely stable field. Critical controls, necessary with electromagnets, are not required. No heat is generated to effect critical conditions . . . and being a permanent magnet, its power won't fail during an experiment. Indiana engineers designed this giant assembly to customer's exact requirements.

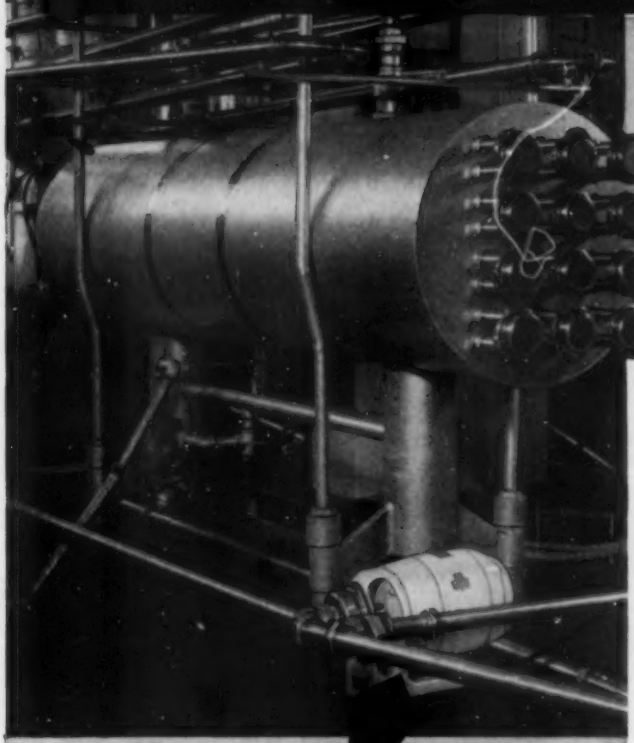
THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

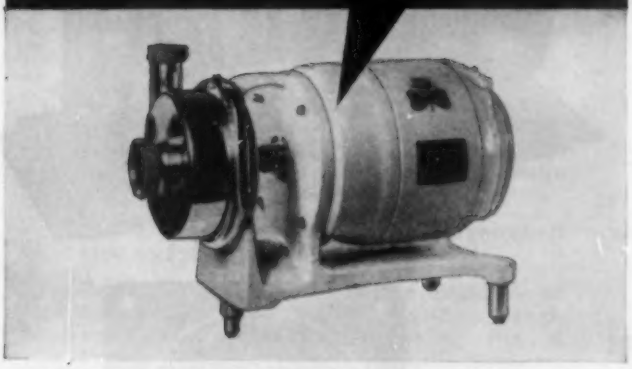
World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

FREE SUBSCRIPTION!
Write for your subscription to *Applied Magnetics* . . a bi-monthly publication carrying helpful, practical information about permanent magnets and their application to industrial and consumer products. Please write on company letterhead.

TRI-CLAMP "Return Cups" provide simple, fast disassembly for cleaning CHESTER-JENSEN HEATER





Included on the Chester-Jensen heater system is the Tri-Clover *"Pump King,"* one of a complete line of Tri-Clover sanitary pumps — that years of service have proven will out-perform and out-last any other centrifugal pumps available to the dairy industry. These pumps feature: *Wide choice of seals — Design that actually exceeds 3A sanitary standards — Streamline heads for faster assembly and disassembly — Patented impeller for higher efficiency — Pump heads that can be turned 360 degrees to simplify installation* — and many other features which make it the most "copied" pump in the industry. *For full details, send for Pump Catalog 253.*

. . . can be used for "take-down" or cleaned-in-place service

• This Chester-Jensen Heater is unique in that it does not employ conventional methods of return flow. Instead, a stainless steel return cup takes the place of complex return covers or fitting assemblies. The return cup is held in place with a simple TRI-CLAMP toggle union.

The advantages of these Tri-Clover snap-action clamps are obvious—faster, simpler original assembly at lower cost—and speedy disassembly for cleaning, inspection, or replacement.

While this is a specialized application of the exclusive Tri-Clover TRI-CLAMP principle, the same basic advantages apply to the full line of TRI-CLAMP stainless steel ells, crosses, tees, laterals, etc., for use in either "take-down" or cleaned-in-place lines. When installed in "take-down" lines, the "easy on and off" feature means a tremendous savings in labor at wash-up time. When used in C-I-P lines, Tri-Clamp fittings offer important savings in both original cost and in maintenance expense.

SEND FOR NEW CATALOG

Complete details and specifications covering the full line of TRI-CLAMP Stainless Steel Fittings are available in the new Tri-Clover Catalog 1-154. Send for your copy today.

3155

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Interval Timers

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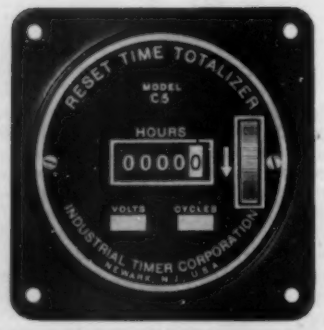
To meet the widely different requirements of our customers, we work with 17 basic types, from which we have so far developed 721 combinations. 19 years of successfully "timing" these customers has equipped us with a breadth of practical experience that you can draw on. The timers we manufacture comprise a complete line in 4 broad classifications.

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

That's why you can depend on us to meet your needs. If we can't do it with one of the 721 combinations already developed, we'll have our engineers get on it at once and develop the combination that's right for you.

Our deliveries are extra good because we maintain large stocks of our 17 basic types, and even if your order is very "special" you'll be more than satisfied with our service. Send us your specifications; you'll get a prompt reply.



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Timers that Control the Pulse Beat of Industry

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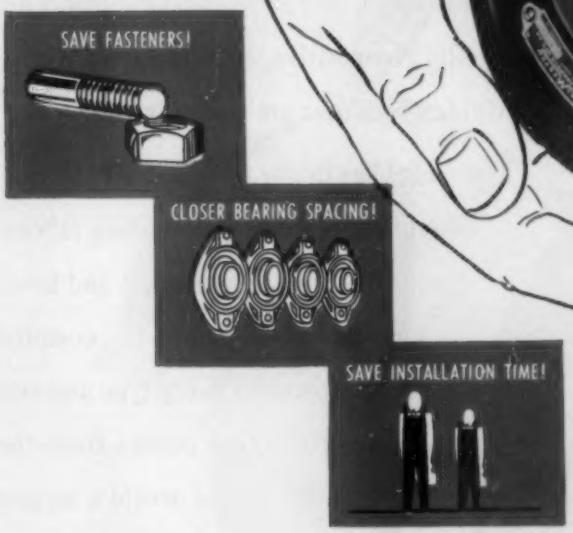

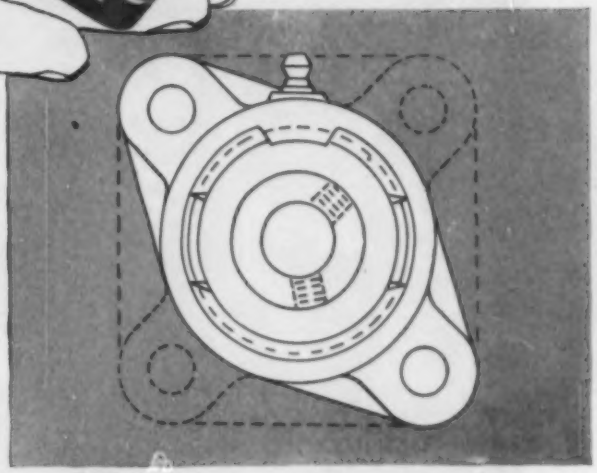

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- Cuts installation costs by eliminating two fasteners and punching or drilling operation required for two mounting holes.
- Permits closer bearing spacing on multiple shaft installations.
- As a replacement bearing unit fits the diagonal bolt centers on present four-bolt flange units.
- Carries the same load rating for a given shaft size as four bolt units.
- Retains all patented design features of SEALMASTER Bearing Units—Zone Hardening, Self-Alignment, Locking Pin & Perimeter Dimple and Labyrinth Seal.
- Available in shaft sizes from ½ to 2 15/16 inches.

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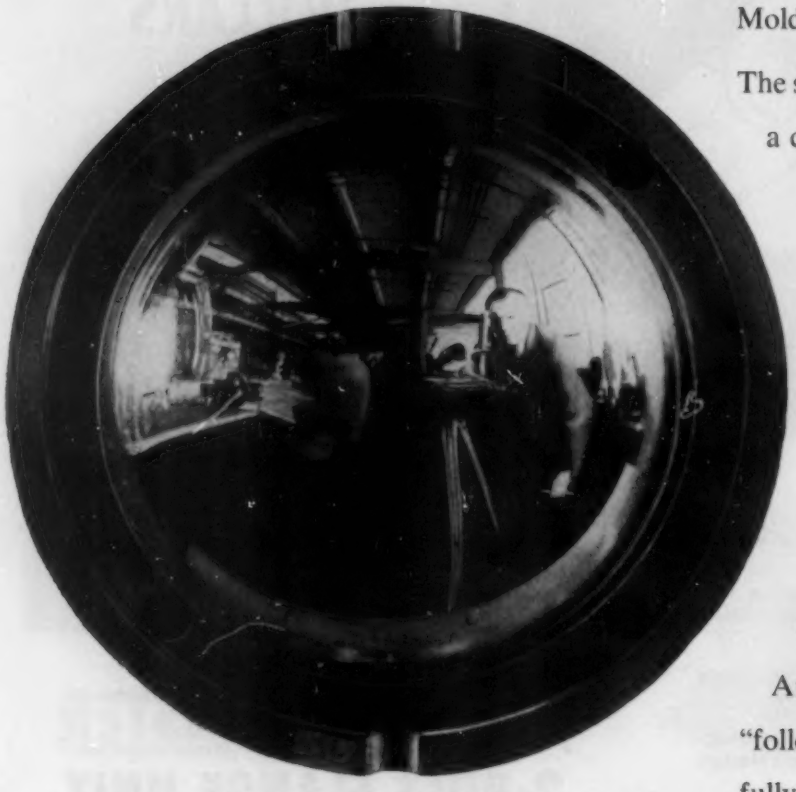

Here's part of an injection-type mold for making Lucite parts. With this superb mold finish, perfect product transparency is assured.

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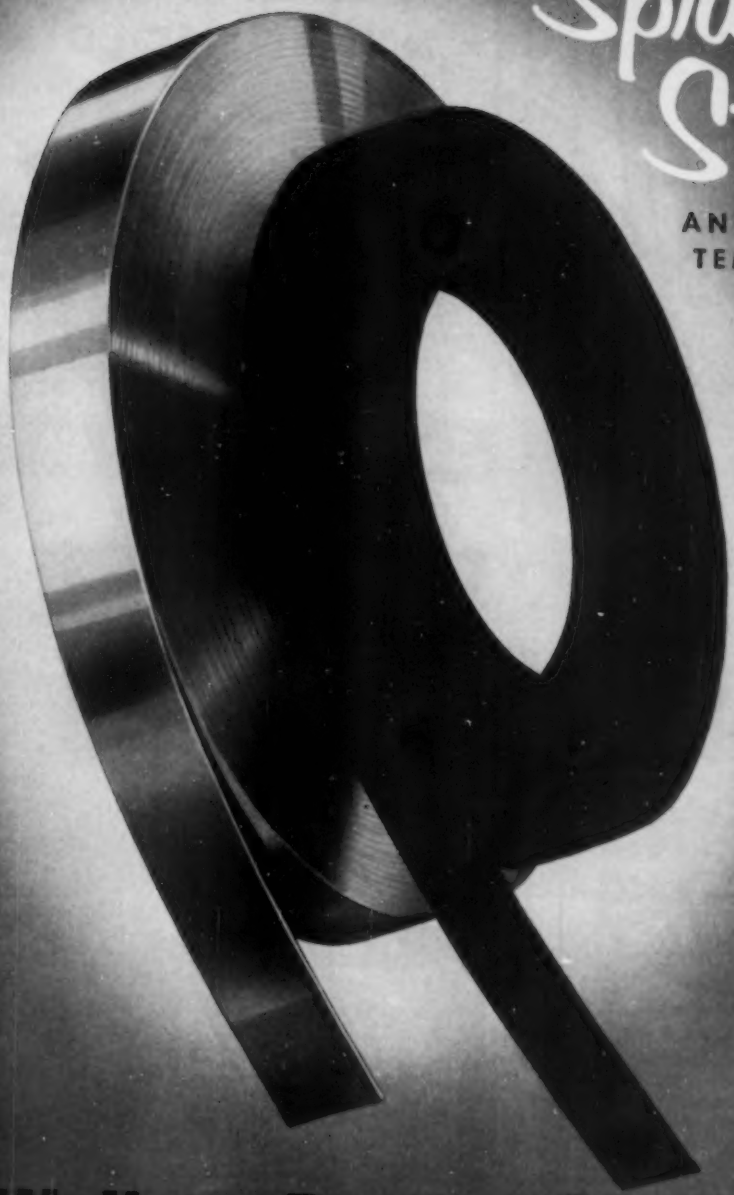

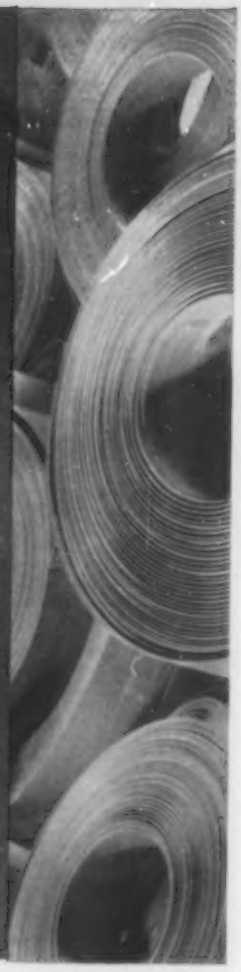

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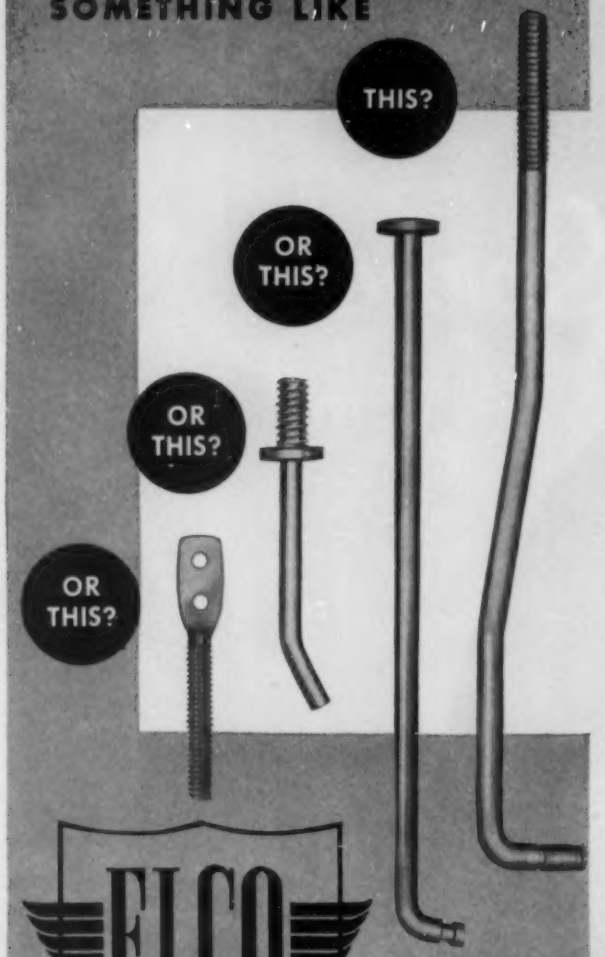

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Cold-heading, of course, produces the shapes, forms, knobs, and upsets. The ends are roll-threaded. Kinks, bends, flats, and other forming is done on suitable machines. The *important* consideration is that ELCO has *all* these facilities, and many more — acquired and developed through years of varied experience, together with a store of versatile ingenuity that can mean *lower costs* for you. *Always consult your ELCO representative.*

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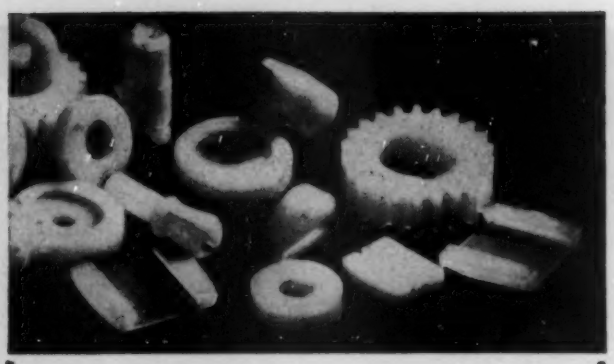

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Standard governor fly-weight principle
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The Synchro-Start governor Model GA-3 has a housing suitable for mounting on an AND20005 aircraft tachometer drive pad. It contains three snap action switches that may be set to open and close circuits at any speeds between 1200 to 10,000 RPM.

DIMENSIONS—Diameter 2⅝"—Length 6"—Weight 1¾ lbs.

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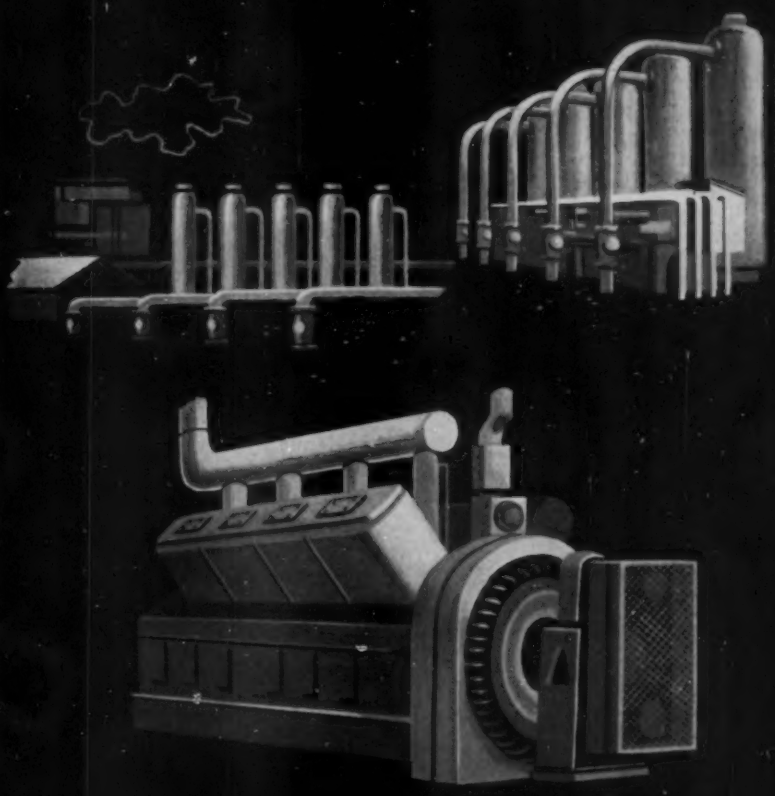
A Control Factor in Performance!



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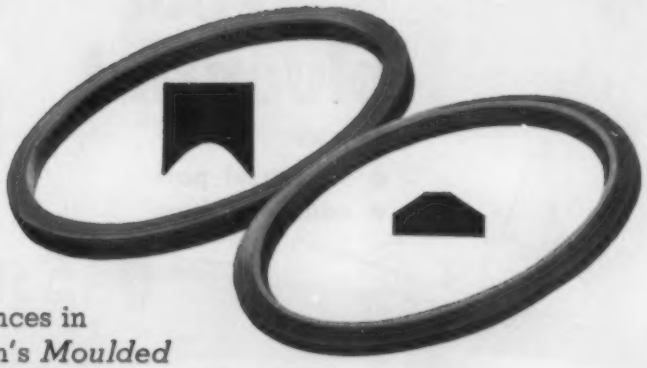

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❶ BETTER SEALING
This moulded, yet resilient female ring *expands* under pressure, helping to form a perfect seal.

❷ NO FATIGUE CRACKING
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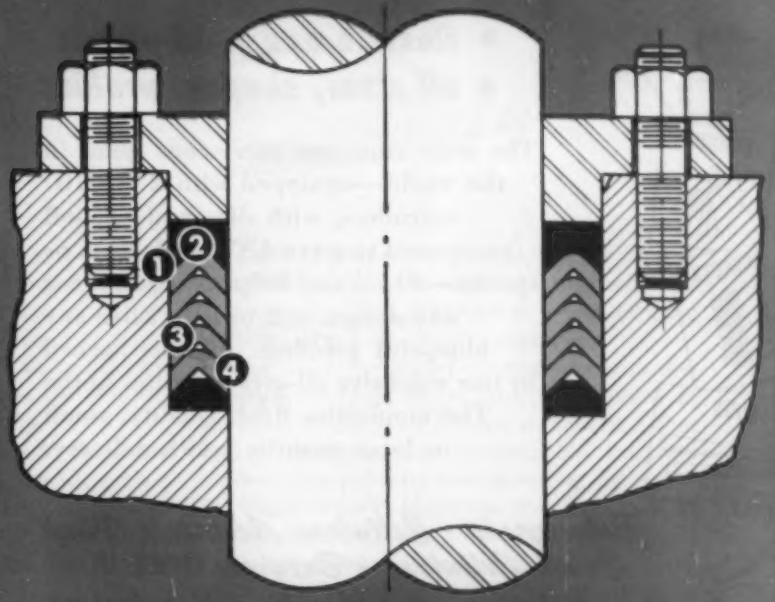
❸ SAVES PACKING
Because of tighter seal, packing cannot extrude around flange ends. This saves packing and reduces friction.

❹ NO CYLINDER DAMAGE
Houghton Adapters are tough and durable but will not abrade or score cylinder walls.



Get the complete story on this new development by writing to Packing Research Division, E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

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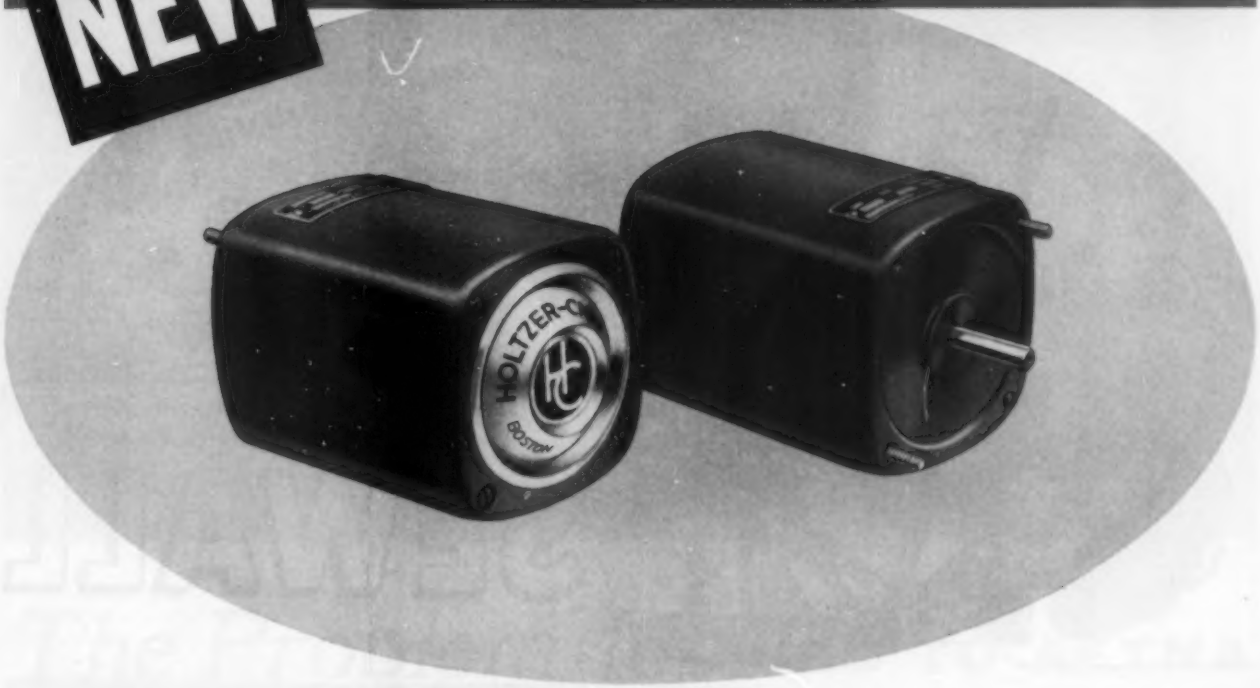

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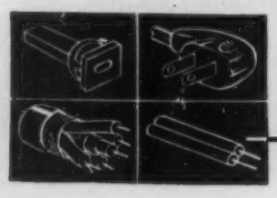

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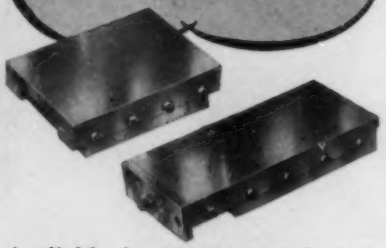

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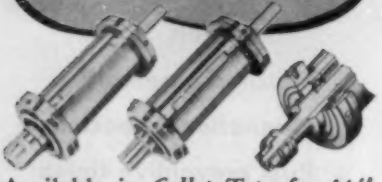

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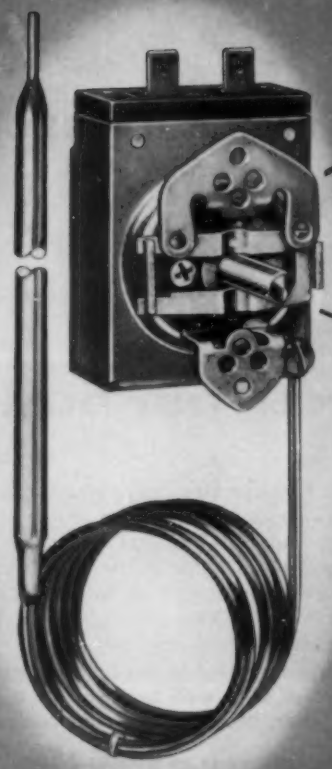

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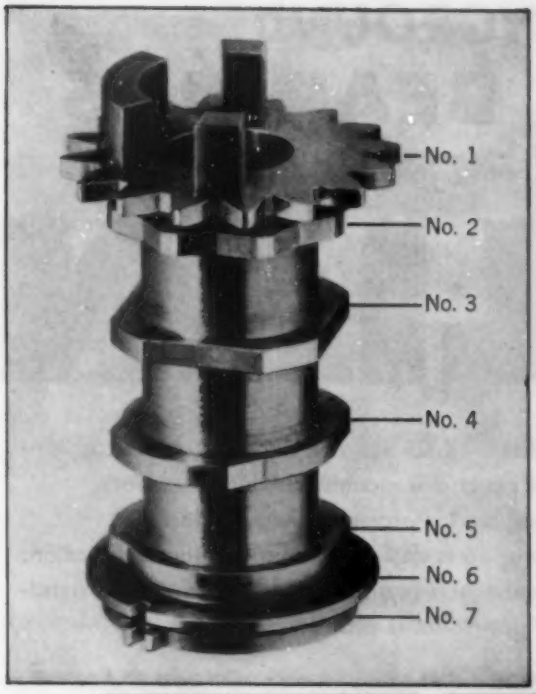

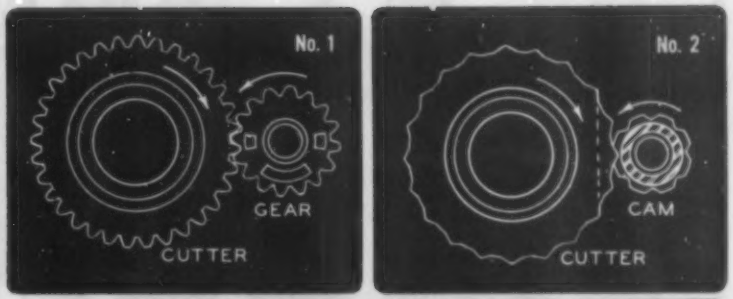

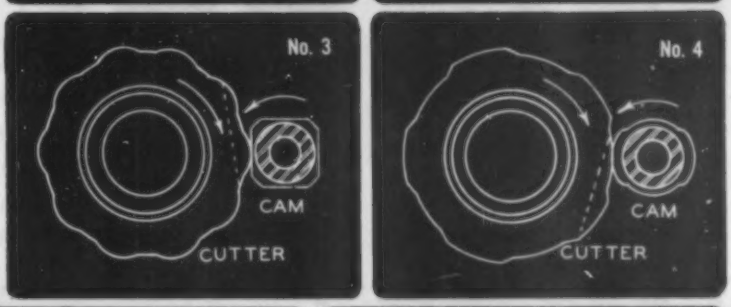

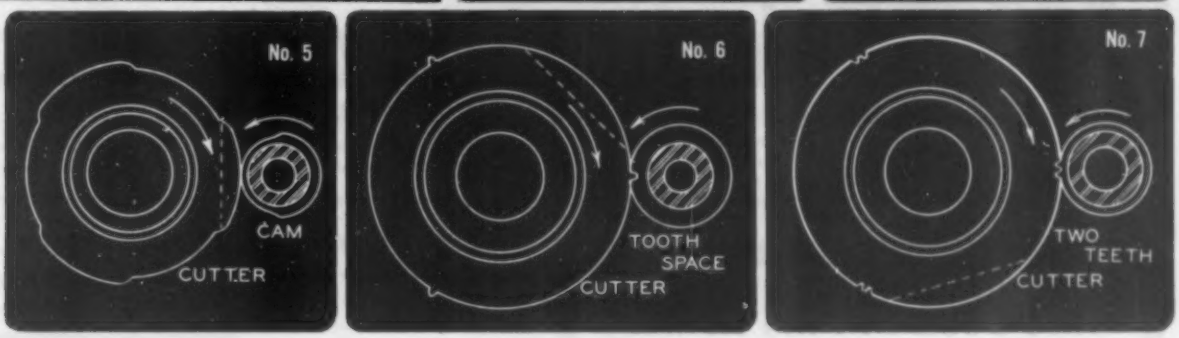

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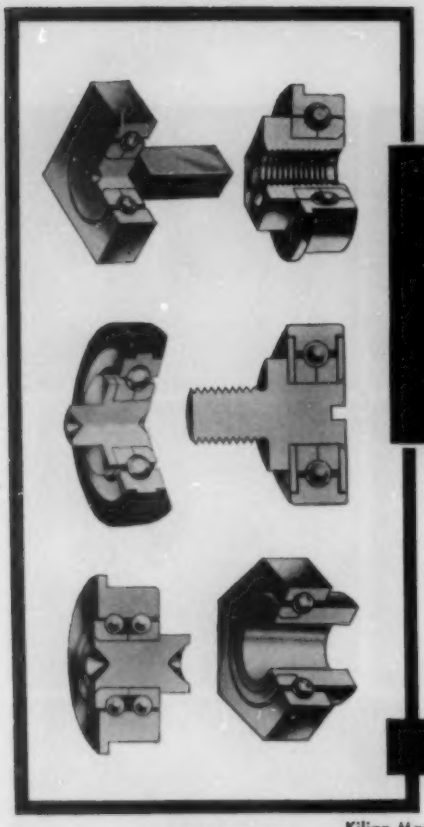

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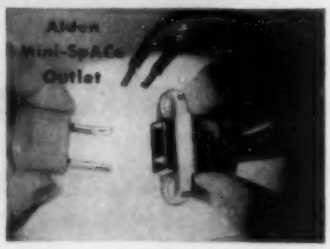

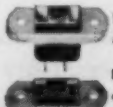

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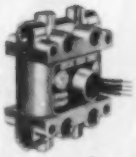
If you need precision control of gas, vapor, hydraulic pressure or vacuum  V9 Four-way if you need special ports, pressures or voltages X5 Explosion-proof or if you need *any other* variation on standard solenoid valves, call in your Skinner engineer *first*. He is sure to be able to fill your needs, for he can draw from more than 100,000 variations on Skinner miniature valves V10 Hydraulic all of which are leakproof, trouble-free and positive-acting. Some have actually proven themselves capable of up to 25,000,000 cycles V5 Universal Call in a Skinner expert today — no problem is too difficult, no quantity too small.

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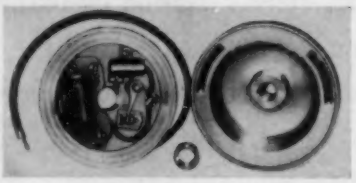

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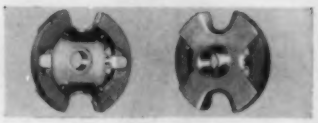

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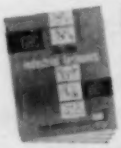

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J&L cold drawn ELECTRICWELD tubing now available with a superior SPECIAL SMOOTH I.D. finish

Reduces your over-all production costs in applications like these . . .

- **cylinder tubing**
- **hydraulic and pressure tubing**
- **shock absorbers**
- **ordnance components**

This new drawn-over-mandrel grade tubing with its mirror-like inside surface finish is today busy helping manufacturers reduce or entirely eliminate costly machining on many applications and is being substituted for more costly types of steel tubing. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

J & L Cold Drawn ELECTRICWELD Tubing with a *Special Smooth* ID finish combines the physical advantages imparted by today's modern electric welding techniques with those of cold working. It withstands high internal hydrostatic pressures, carries heavy torsion loads, resists high-frequency vibration, and offers a favorable weight-to-strength ratio for applications in which loading occurs in all directions.

J & L Cold Drawn ELECTRICWELD Tubing can be furnished in its three specifications in OD sizes from ¾-inch to 2¼ inches and in wall thickness from 20 to 10 gage, 0.035 and 0.134-inch respectively.

This new booklet provides the information you need . . . specifications . . . tolerances . . . chemistry . . . mechanical properties . . . annealing . . . finishes.

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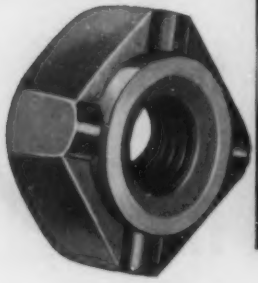

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Midland Welding Nuts may be the answer to your dreams if you're in a business which fabricates, fastens, or assembles metal parts—OR, if you're a designer of products incorporating such parts.

Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

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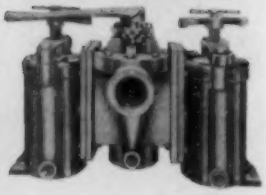

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Kraissl Class 72 duplex separators are designed so that you don't need to use a lifting jack to raise the rotary plug valve. The valves are designed to a sufficiently wide angle taper — so that the plug does not wedge on its seat, through wear and use.

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A REVOLUTIONARY "FIRST"—THE WORLD'S ONLY BALL BEARING SPLINE!

New Saginaw b/b Spline makes all ordinary splines obsolete!

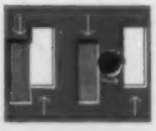
By applying the well-proved principle of the recirculating rolling ball (already made famous by the *Safety b/b Screw*), Saginaw has *revolutionized spline design!* The new *Safety b/b Spline* is so far superior to any spline ever before built that engineers are eagerly adopting it.

In any application where column length must change under torque load, the *Safety b/b Spline* offers unprecedented freedom from spline restrictions.

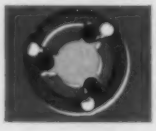
AVAILABLE IN ALMOST ANY SIZE, BEGINNING AT ⅜-IN. DIAMETER

Every *Safety b/b Spline* is individually engineered for its particular application, with the wealth of know-how that only Saginaw, the pioneer, can offer. Our engineers are ready and eager to help you.

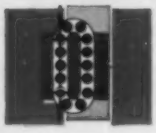
WHAT IT IS AND HOW IT WORKS:



Let's start with the familiar principle that there's far less friction in *rolling* than in *sliding*. The average coefficient of friction of the sliding spline is .2—while that of the ball/bearing spline is only .005.



By applying this principle, the *Safety b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, the mating surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of both the inner and outer splines. Ball guides return the balls to their starting point.

Averages 40 Times Lower Coefficient of Friction Than Sliding Splines!

Imagine what this tremendous advantage can mean in your products or processes! The *Safety b/b Spline* can be fitted with integral gears, clutch dogs, bearing and sprocket seats or other attachments for use with electrical, hydraulic or pneumatic units—forming a unit with unprecedented possibilities for the imaginative design engineer. It can enable you to:

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INCREASE DEPENDABILITY— Greatly decreased friction means less wear—longer life—safer, more dependable operation is assured.

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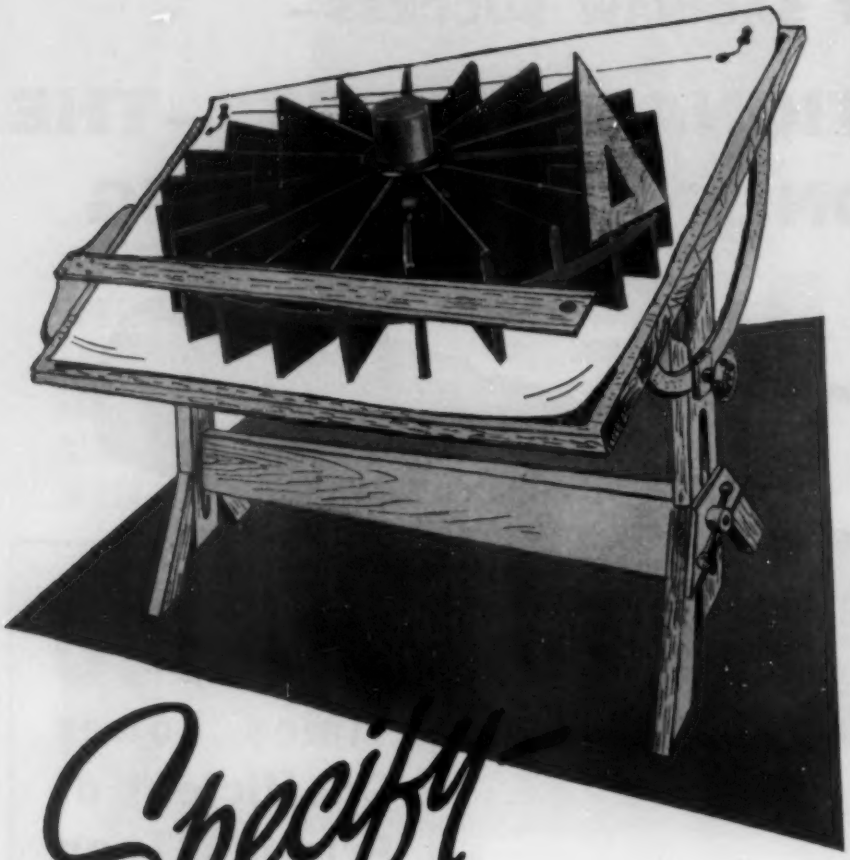

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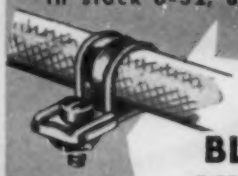

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However, a start toward eliminating this problem *has already been made*. We've printed for the use of all designers and draftsmen a two-color folder illustrating the symbols which we think best meet the need for simplicity. The material is based in the main on the Engineering Drafting Standards of the Ford Motor Company, backed up with data from the American Standards Association, and from the National Machine Tool Builders' Association. Copies are available at 15c. each.

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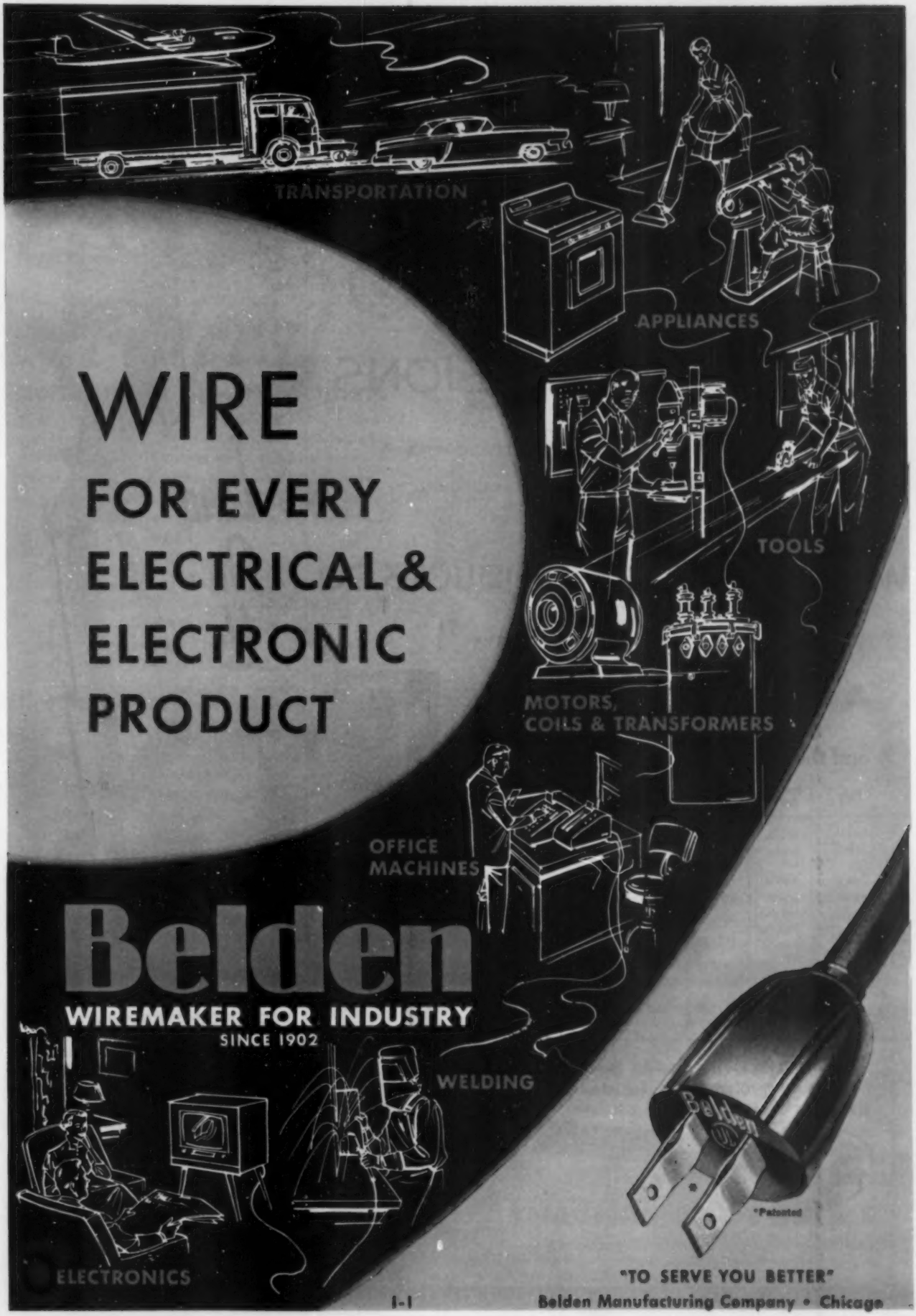
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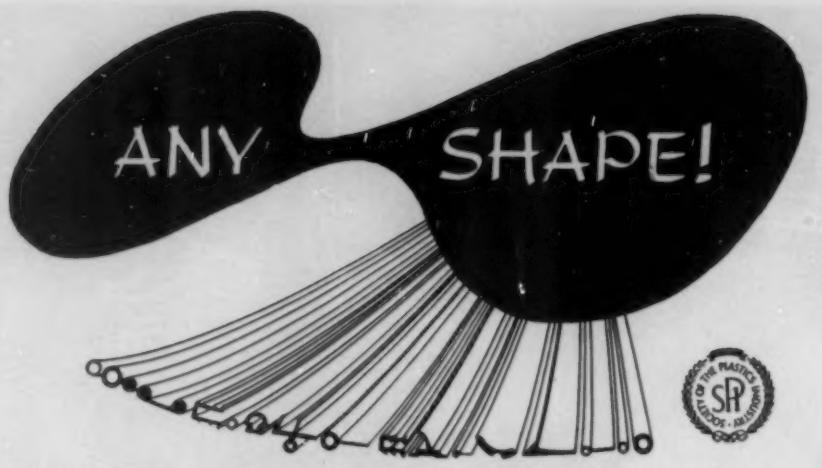

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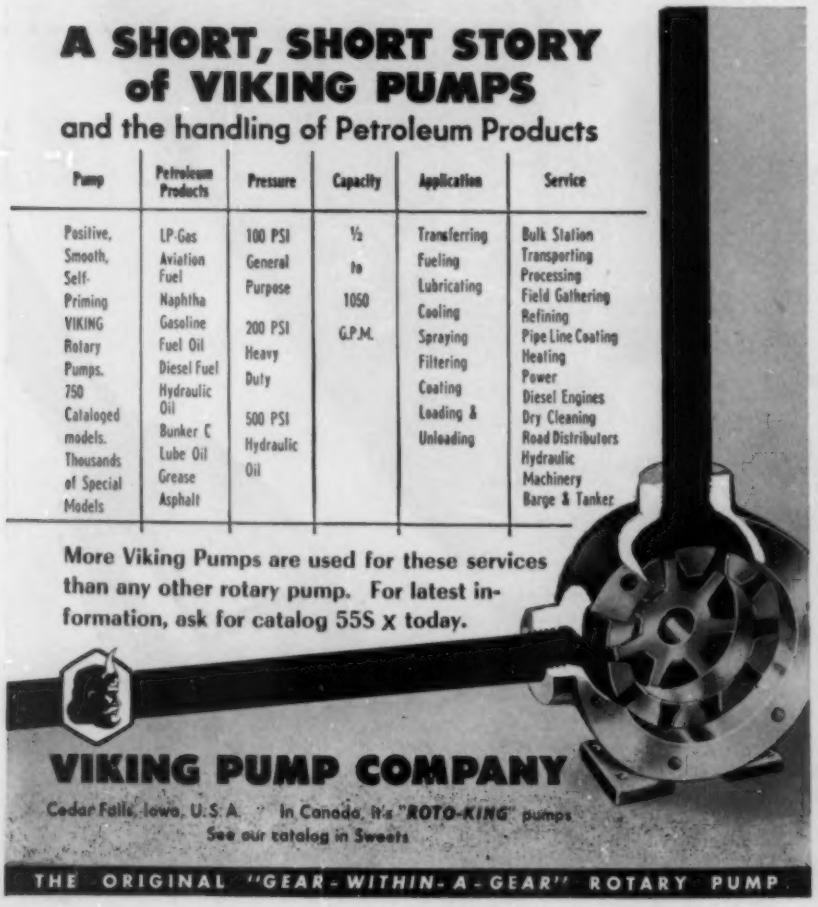

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The benefits of Federal's exacting standards of fabrication and testing are now within reach of every user of germanium rectifiers. Federal craftsmanship assures at least *20% lower reverse current than the RETMA specifications for every IN91, IN92, and IN93 rectifier.*

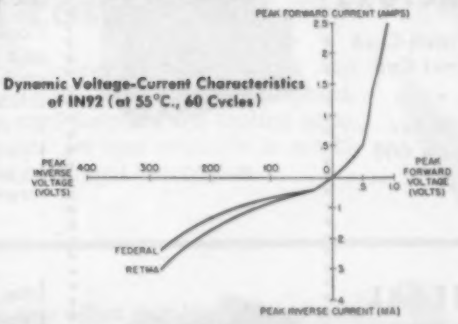
FEDERAL, pioneer developer and manufacturer of semi-conductor products, has just completed a major expansion of its germanium rectifier production facilities . . . NOW, production quantities of diffused junction rectifiers are available for general industrial use.

ELECTRICAL RATINGS

(based on 55° C ambient T., resistive loads, 60 cycle input)

CHARACTERISTIC	IN91	IN92	IN93
Peak Inverse Voltage, Max. (volts)	100	200	300
RMS Input Voltage (volts)	70	140	210
RMS Input Voltage (capacitive load) (volts)	35	70	105
DC Output Current, Max. (ma.)	150	100	75
*Leakage Current at Rated Peak Inverse Voltage (ma) (Retma Limits)	*2.7	*1.9	*1.2

*Limits established by Federal assure at least 20% less leakage.



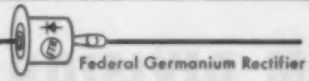
100% OF FEDERAL GERMANIUM RECTIFIER PRODUCTION IS 100% TESTED

For more information about Federal Germanium Diffused Junction Power Rectifiers call Nutley 2-3600, or write to Dept. F-742.

IN368 Designed for magnetic amplifier and blocking applications where very high forward-to-reverse current ratios and high efficiencies are required. *Meets all RETMA specifications!*

IN368 ELECTRICAL RATINGS

Maximum Peak Inverse Voltage	200 volts
Maximum DC Output Current	100 ma
RMS Voltage	140 volts
Continuous Reverse Working Voltage	150 volts
Max. Leakage Current at 150 Volts Reverse DC	300 microamps DC



Federal Germanium Rectifier (actual size)

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A.C. MAGNETIC STARTERS
with Plasti-Clad Magnet Coil
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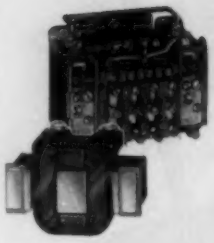
Write for Bulletin 605



Full accessibility in a small package.

Contacts, coil and thermal element replacement with use of screwdriver only. Magnet coil—in molded phenolic case with riveted terminals—is completely embedded in a rock-hard resinous material, thus protecting against oil, dirt, moisture and normal mechanical damage.

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50% smaller — lighter.

R-B-M 22204-0 meets AN 3304-1 specifications. R-B-M engineers have developed the 22300-0 currently used in government electronic, airborne and ground equipment—as the electrical and mechanical equivalent of the AN 3304-1, yet 50% smaller in size with ½ the weight.

INDUSTRIAL CONTACTORS
with Plasti-Clad Magnet Coil
•
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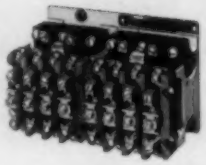

2-8 poles Non-Reversing.
2-5 poles Reversing.
25 Amp — 600 AC Max.

Contacts can be replaced without removing wiring. To change coil, remove magnet frame and coil assembly only. 10 and 15 amp. poles can be changed from normally open to normally closed by using screwdriver only.

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Low cost. Small size. Dependable performance. Available in many contact arrangements.

Whatever your needs for inexpensive, dependable relays for commercial applications—investigate R-B-M General Purpose Relays.

Other R-B-M products include: motor overload protectors, motor starting relays and low voltage DC electrical devices.

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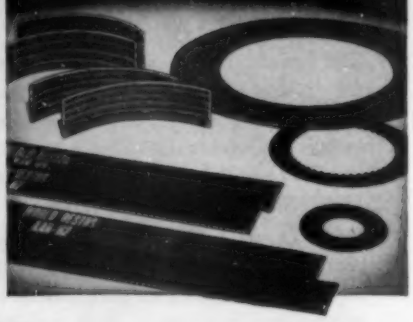

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Where appearance and performance call for quality parts, don't overlook the advantages of stainless steel fasteners. Take the illustrated E. W. Ferry fasteners, for example. They're priced right in line with quality fasteners of other materials. Yet they offer all the extra qualities stainless steel brings to any part — high tensile strength . . . attractive, rust-resisting finish . . . and remarkable resistance to heat and corrosion. In almost any application they outlast, many times over, fasteners of nonresistant or plated metal. They cut maintenance costs, too. For even after years of service, disassembling rust-free stainless fasteners is always a fast, easy operation.

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The hardness of stainless steel fasteners results in substantial savings on the assembly line. Work is faster, results are better — simply because stainless screw-heads are less apt to burr and nick. This means major savings, for even a slipping screwdriver can seriously damage both the screw and the parts being assembled. Stainless steel fasteners cut tooling costs, too. For they are now available in practically every size and description.

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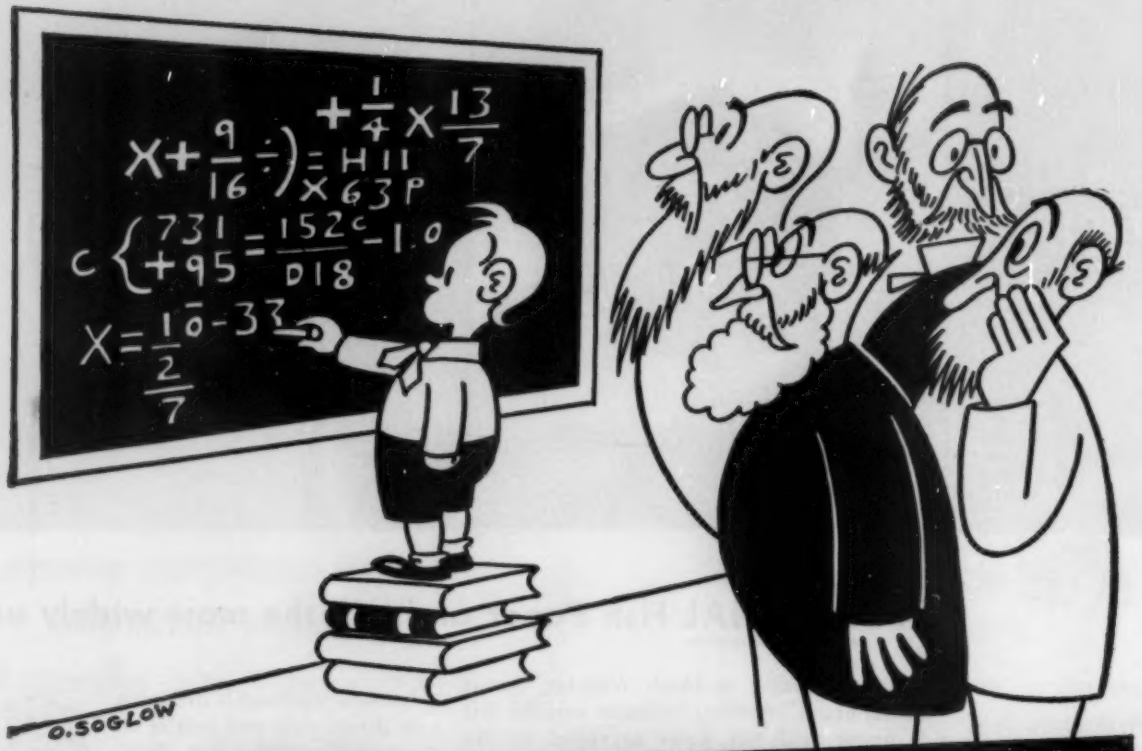

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- Sales in 1954 exceeded *all redemptions* in that year of matured E Bonds and unmatured E and H Bonds by more than $400 million—the highest net amount since 1949.

- Cash value of E and H Bonds outstanding reached a new record high of $38.2 billion, a gain of $1.5 billion in 1954.

- This $38.2 billion cash holding by individuals represents 14% of the national debt. Never before has the national debt of our country been so widely held.

These figures, far more effectively than mere words, tell the story of The Payroll Savings Plan—why it is good for America, why it is good for business. If you do not have the Plan, or if you have the Plan and your employee percentage is less than 50%, phone, wire or write to Savings Bond Division, U. S. Treasury Department, Washington, D. C.

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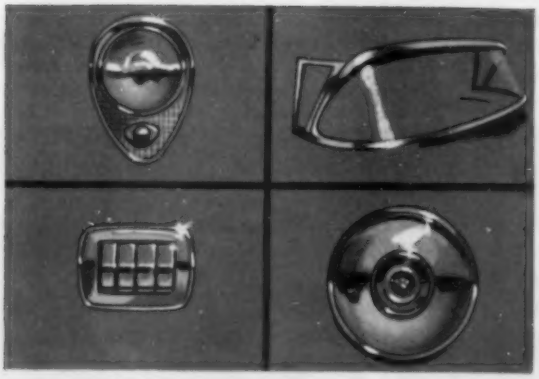

The beautiful bright molding and trim that style your car are made of non-corrosive, easy to clean Stainless Steel. Designers of automobiles and hundreds of other products specify Stainless Steel for its many valuable properties.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.

McLOUTH STEEL CORPORATION
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

Photo courtesy Martin Aircraft

Martin Jet Bomber B-57B—package of engineering ingenuity wields new speed and mobility in this

★ Modern Arm of the Air Force ★

Wrapped up in this modern arm of the skyways is the wizardry of Martin engineers—masterminds who gave this fighting bomber a supremacy of visibility, mobility, speed and control.

In the success of this fighting craft, Continental takes modest pride in being selected to engineer and supply many of the molded and extruded rubber parts. A typical example is the cockpit seal which must not craze plexiglass and yet must remain flexible *even* at −70°!

Compounding and extruding rubber that will not craze plexiglass is a problem in itself. Producing rubber to remain flexible at −70° is still another. Furthermore, this part must have an exceptionally low compression set in order to retain its perfect seal. Resistance to every weather condition is *also* a must.

Producing a rubber part to meet all these critical specifications was a real challenge! Proper plasticizers had to be chosen, extensive laboratory tests conducted, and special handling was necessary to maintain the extremely close tolerances required. A challenge that Continental met and exceeded because of their 50 years' skill and experience in the specialized art of molding and extruding rubber.

The technical assistance offered for this part typifies the service available at Continental. When you need "engineered rubber parts," enlist the service of specialists—consult Continental.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**

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Want Help with Your Design Problem?

Hundreds of America's consulting design engineering firms are prepared to give you assistance when your own facilities are overcrowded . . . they're organized to complete projects quickly when speed in development is essential . . . and they often can give you a fresh viewpoint on product design.

These are just a few reasons why you may find it profitable to call in one or more of these consulting firms. And whether you may need the assistance of a consulting firm now or in the future, we can help you locate the firm or firms best able to service your needs. We recently completed a study of the consulting engineers that subscribe to *Product Engineering*. The information compiled has been indexed and filed by our Research Department, and is available to you.

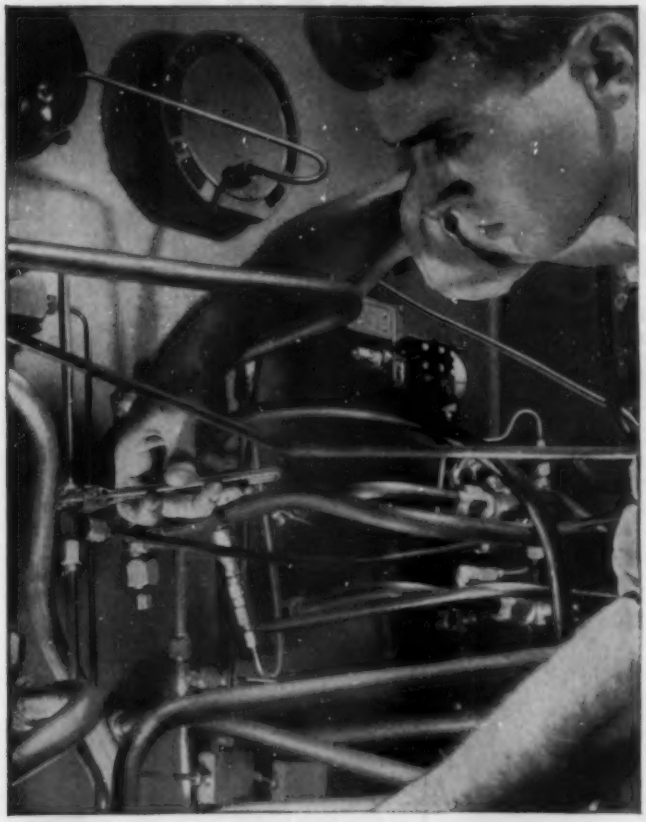
The files, for example, contain data on firms which do up to $5-million in business annually . . . employ from one to as many as 500 engineers and technicians . . . and which, in most cases, can design any kind of machinery and equipment. These companies also specified the one or more areas of design—mechanical, hydraulic and pneumatic, electronic and electrical, appearance, and other types—in which they work.

Almost all of these organizations indicated that their services are complete to the extent of specifying materials and components, preparing bills of material and work drawings for the products they design. They also stated the geographical areas in which their services are available. And many companies, in addition to replying to our questionnaire, furnished bulletins and brochures covering their activities, photographs of products designed, and lists of clients served and patents awarded.

To take advantage of this wealth of data, call or write our Research Department. There's no cost or obligation, of course.

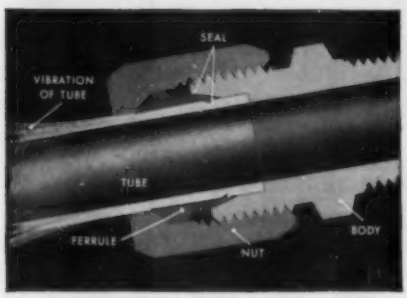
Product Engineering

McGraw-Hill Building, New York 36, N. Y.

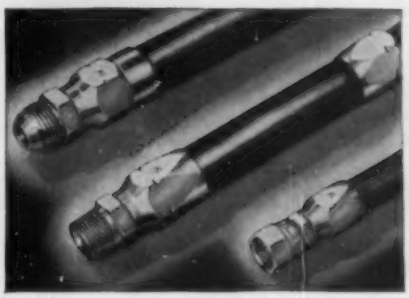


"Tube up and forget it" with leakproof Parker fittings

Triple-lok flare fittings are the easiest, fastest and safest way to tube up even in close quarters. They are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. *Triple-lok* fittings meet J.I.C. and S.A.E. Standards plus specifications of the A.S.M.E. Code for Pressure Piping. Available for tubing outside diameters from ⅛ through 2 inches. More *Triple-lok* fittings are used on industrial machinery than any other fittings.



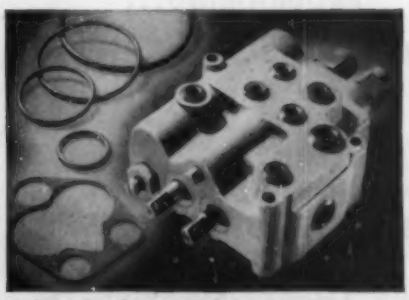
Ferulok flareless fittings, featuring the visible "bite", are especially for high-pressure, heavy-wall tubing. Cutaway shows why vibration won't break the seal.



New Hoze-lok fittings and hose assemblies (for medium and high-pressure hydraulic service) offer better performance, easier make-up, greater re-usability.

New Weld-lok fittings are machined from high-quality steel or stainless-steel bar stock and forgings. They are available for tubing ¼ through 2 inches, O.D.

New Intru-lok tube fittings can be quickly installed by anyone. Simply push tube in, then tighten nut. Designed for instrumentation lines of ¼ through ½ inch, O.D.



Other Parker products include new hydraulic control valves, check valves, accumulators and O-rings. Mail the coupon for the fitting catalogs you want.

TUBE AND HOSE FITTINGS DIVISION
Section 411

The Parker Appliance Co.
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Cleveland 12, Ohio

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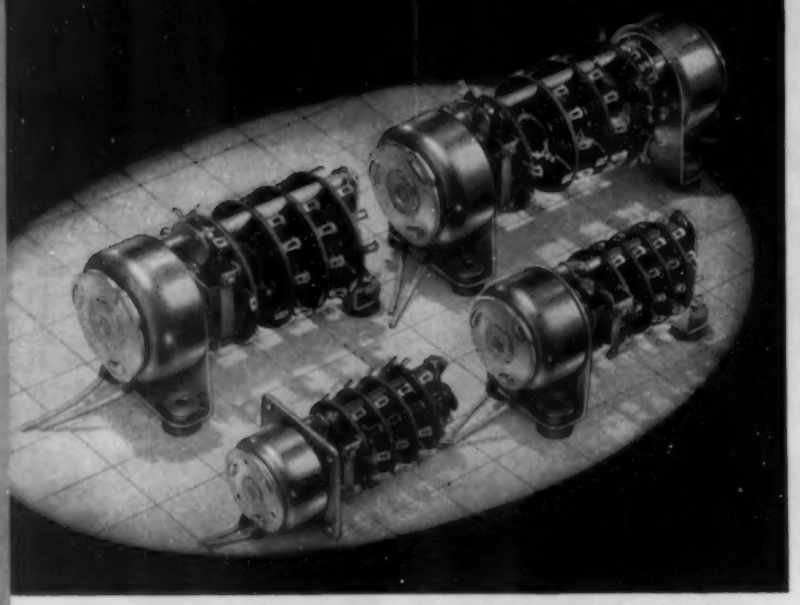
WILL HELP YOU SIMPLIFY REMOTE SELECTION of CIRCUITS!



A few examples of standard Model, Ledex relays. Use the 1" squares in the background to estimate size of the relays.

Ledex Relays are available to perform a variety of switching jobs... STEPPING...COUNTING...ADDING AND/OR SUBTRACTING...PROGRAMING... CIRCUIT SELECTING...and HOMING.

SEND US, ON YOUR LETTERHEAD, THE DETAILS OF YOUR SWITCHING REQUIREMENTS AND LET LEDEX ENGINEERS WORK WITH YOU TO DETERMINE IF LEDEX RELAYS ARE THE ANSWER.

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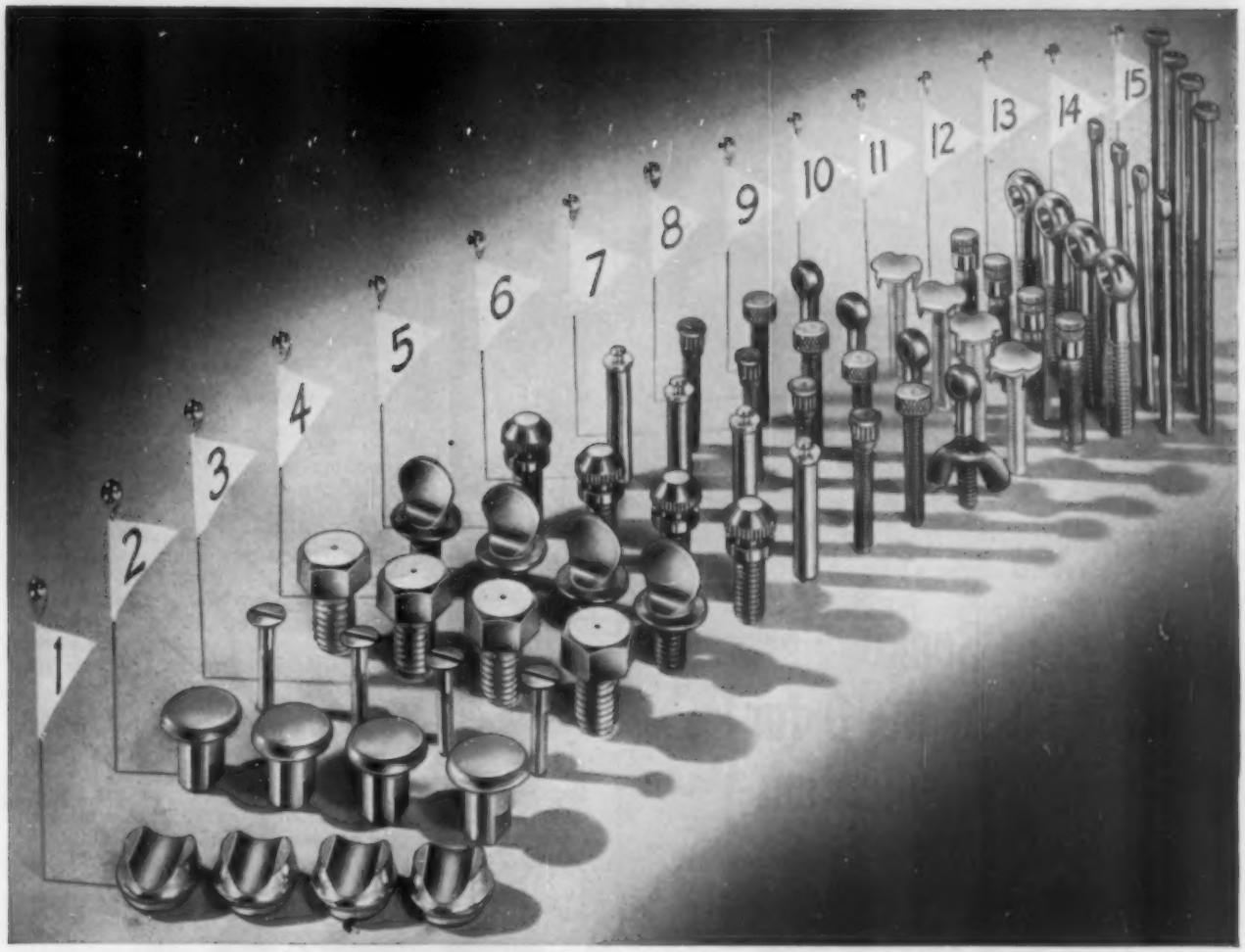

This Army of Specials Marches to Save You Money

Here are a few of the many specials produced by Harper to save industry money—to do a better job.

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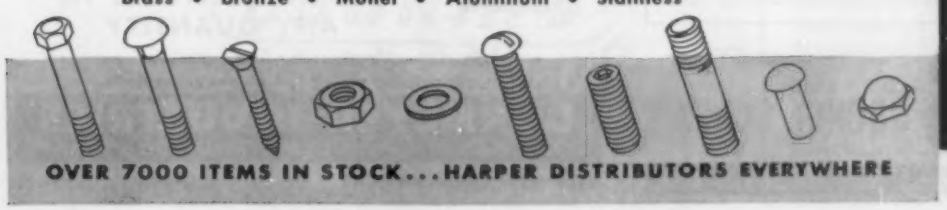
9. Stainless Steel Focusing Screw
10. Stainless Steel Hinge Pin
11. Brass Hold-down Screw
12. Brass Terminal Block Screw
13. Monel Eye Bolt
14. Copper Conductor Pin
15. Stainless Steel Hex Head Stem Bolt



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Designed to fit right in with today's automation techniques, millions of Bristol's Multiple-Spline Socket Screws are used every year by leading makers of computers, instruments, guided missiles, razors, cameras and other precision products.

Ask your industrial distributor for Bristol's Multiple-Spline Socket Screws today. He's got them in sizes down to No. 0 wire. A.5.4

Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

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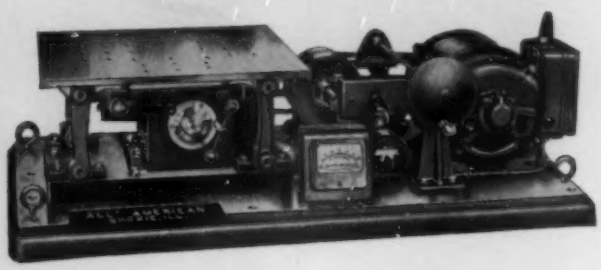
THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

Parts, Assemblies, Up to 150 lbs. Given Vibration Fatigue Test on the ALL AMERICAN Model 150 HLA-D



This heavy duty, precision machine—newest in the All American line—subjects parts or equipment up to 150 lbs. in weight to thorough, accurate vibration fatigue test. 50% overload factor. Sturdy, anti-friction bearing mechanism. Range Selector (automatic frequency control) changes acceleration automatically from 10 to 60 cycles per second and back, or any choice of cycles within that range. After finding critical vibration point, frequencies can be held there to determine final breakdown of part being tested. Produces vibration horizontally in simple harmonic motion.

Recommended for testing of electronic, electrical, aircraft, ordnance, automotive, projection, and other equipment. Learn the numerous advantages of vibration fatigue testing; send for copy of Catalog F which contains helpful data, nomograph chart, lists typical users and applications and shows all models. Write to ALL AMERICAN TOOL & MFG. CO., 8021 Lawndale Avenue, Skokie, Ill.

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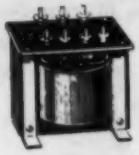

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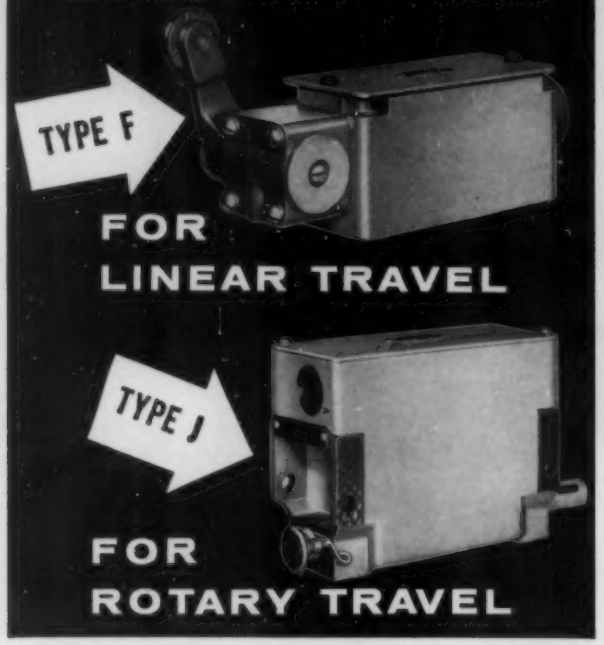

Both Cutler-Hammer Limit Switches shown above are widely preferred because of their tremendous range of adjustment, flexibility of application, and dependability of operation.

THE BULLETIN 10316 TYPE F

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AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine – the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you—giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

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FACT:
Steel is two to three times as strong as gray iron.

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GRAY IRON
Tensile strength
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FACT:
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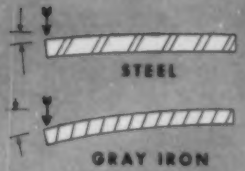


STEEL

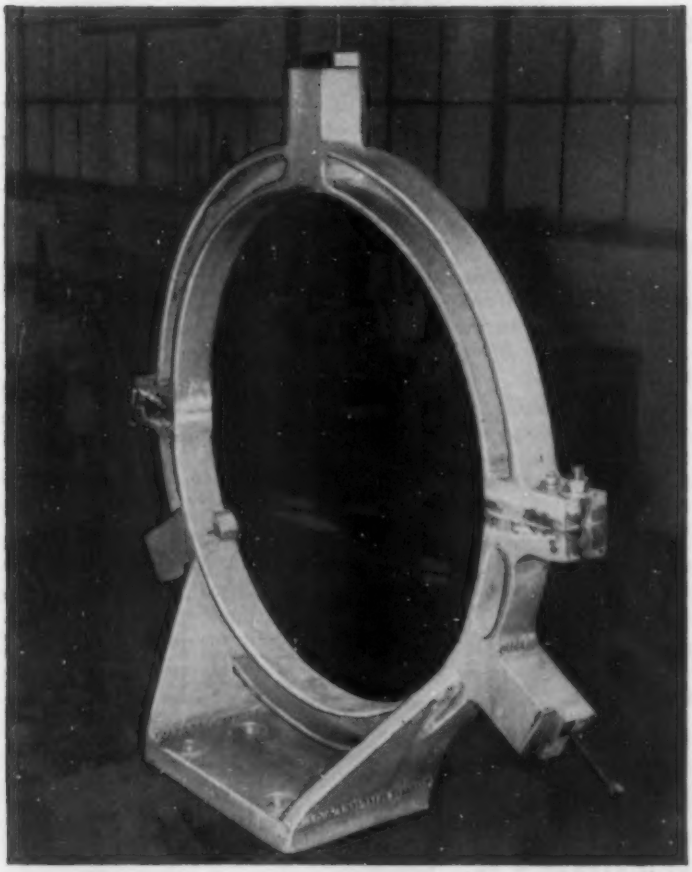
GRAY IRON

FACT:
Steel costs only a third as much as gray iron.

STEEL GRAY IRON

AND SO... *by manufacturing your products from welded steel, costs can be reduced up to 50%.*

WELDED DESIGN COSTS 36% LESS



...lighter yet more rigid

COST of producing this oversize steady rest for a Boye & Emmes engine lathe has been cut 36% by designing for welded steel construction. New design is stronger, more rigid and easier to mount on the lathe because it is lighter than comparable capacity cast iron rest.

Additional savings of $320.00 resulted by eliminating the need for a pattern. No filling or grinding is necessary. Only work required with new steel design is machining and painting.

Savings like these are possible on many of your products. Have a Lincoln representative analyze your products and show how welded steel can be put to work to simplify production and cut your costs.

WELDED STEEL DESIGN *of 36" maximum capacity steady rest for engine lathe is fabricated from steel plate. Fillet welds are made in fast, down-hand position. Photos courtesy of Boye & Emmes Machine Tool Co., Cincinnati, O.*

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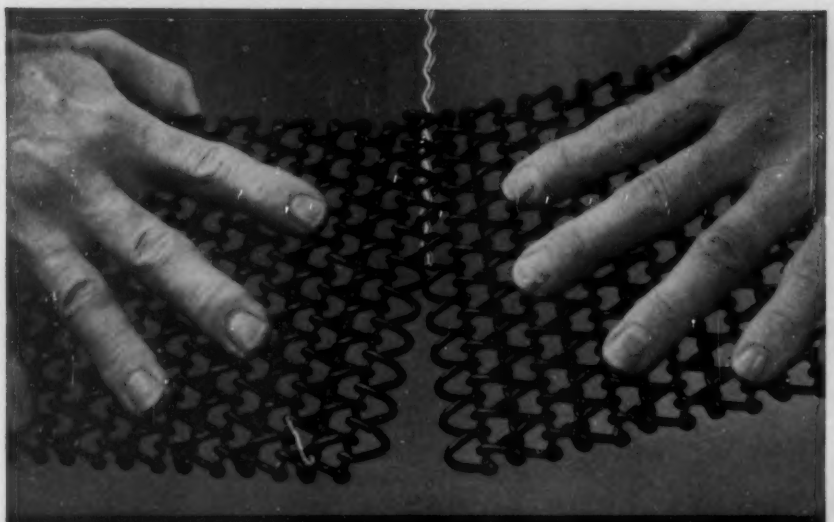

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ASK FOR FREE 130-PAGE REFERENCE MANUAL illustrating and describing woven wire conveyor belts. Gives mesh specifications, design information and metallurgical data.

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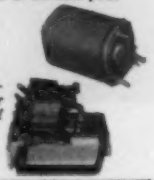
One of today's most versatile relay lines, AEMCO relays are "first choice" for more than 100 of the top names in American industry. Design and construction is tops—for only the finest materials are used in AEMCO relays. Specify AEMCO and you're making your best relay buy. You'll profit by the newest production techniques that speed up delivery and save you money. You'll appreciate the prompt delivery on prototypes, the fast tool up for production. You'll find, too, that an AEMCO relay has more lives than a cat and is built to take it! Actually tested on the job, AEMCO relays are dependable and reliable . . . standouts for performance.

AEMCO relays are available in a wide variety of spring and coil combinations, operating potentials and contact ratings. Types include: Open, can, plug-in base, hermetically sealed, midgets, dual-purpose, delayed make or break, circuit control, current and potential relays. Should one of the hundreds of AEMCO relay types fail to meet your exact requirements, we will be happy to design and build a unit to meet or exceed your specifications.



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AUTOMATIC ELECTRIC MFG. CO.
83 STATE ST. • MANKATO, MINNESOTA

Richardson design and molding service..

Reduces Unit Cost From 75¢ to 11¢!

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The problem: This is a metal tray . . for taking dental impressions. Because trays of this type were relatively expensive (75¢ each), dentists found it necessary to clean and re-use them. In spite of careful cleaning, the trays would corrode, oxidize, discolor and, after repeated use, become generally unattractive.

What was done about it: The Wm. Getz Corp., Chicago, asked Richardson to recommend a material and design a new plastic dental tray. Richardson engineers suggested a clear polystyrene material and designed and constructed, for economical production, this complicated 10-cavity mold weighing 2322 pounds.

AFTER 11¢

The result: This plastic dental tray is more sterile and has much better eye-appeal. It costs only 11¢ instead of 75¢ . . a savings of 85% which permits the dentist to discard each tray after it has been used. Tedious time-consuming cleaning of old metal trays is no longer necessary.

Are you redesigning your product for better sales-appeal? Richardson engineers, consulting with your own engineers, can help in the development of design changes for better performance, improved appearance, and lower production cost. Complete laboratory facilities are available for the development of special plastic materials for your applications. Experienced Richardson tool and diemakers can produce your molds for efficient parts molding.

For detailed information write or phone The Richardson Company. 2793 Lake St., Melrose Park, Illinois (Chicago area)

RICHARDSON PLASTICS

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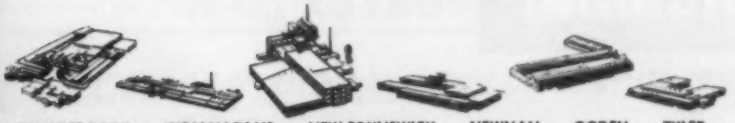

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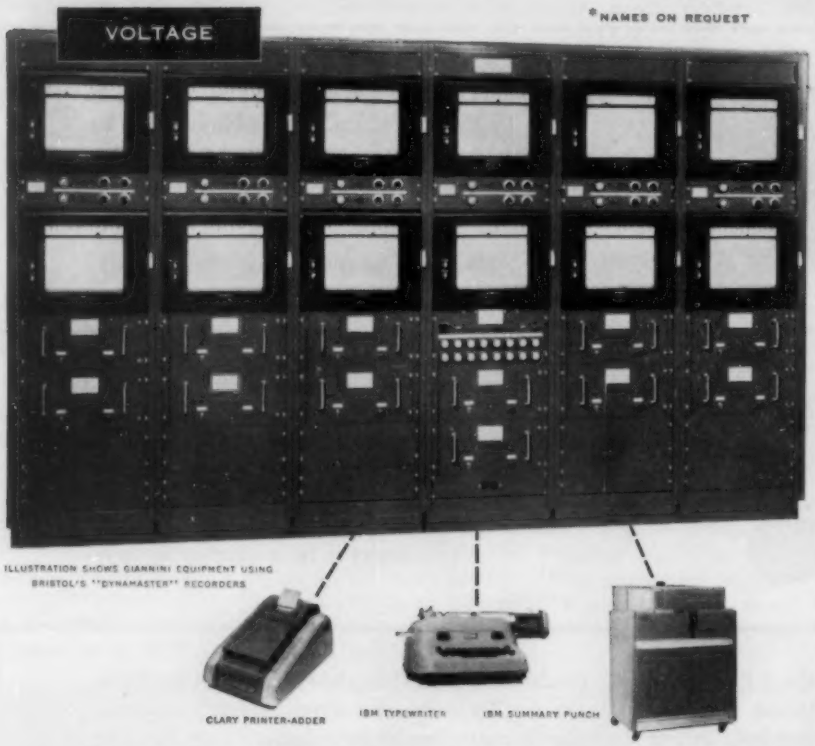

ILLUSTRATION SHOWS GIANNINI EQUIPMENT USING BRISTOL'S "DYNAMASTER" RECORDERS

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CORNING GLASS BULLETIN FOR PRODUCT DESIGNERS

CORNING GLASS WORKS, 10-10 Crystal Street, Corning, New York

Please send me the material checked below:

☐ B-83: "Properties of Selected Commercial Glassware." ☐ B-84: "Manufacture and Design of Commercial Glassware." ☐ Booklet: "Glass and You."

Name_____

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Company_____

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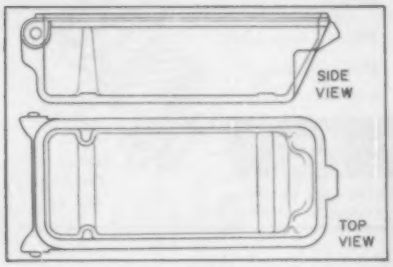
Bold mold

It has come to our attention that often simplicity embraces complexity.

A good case in point: the dental tray you see pictured. It's a relatively simple outfit for sterilizing small instruments by immersion. A product of the Bard-Parker Co., it's made of a PYREX brand glass, metal, and rubber.



Our contribution to the working simplicity of this sterilizer is the glass body. Actually, this main component is a quite complex, one-piece object, *molded* of one of our most versatile glasses, PYREX brand No. 7740.

A close look at the illustration will give you some idea of the many angles, radii, ridges and such to be calculated in making the molds in which this tray is pressed. Yet, its precise tolerances allow the metal and rubber cover to fit and hinge on the glass lugs, and the inside metal tray rests evenly on the built-in glass supports for draining.

At the risk of repetition, we mention again that all this is *molded* in one piece of glass.

Which brings us to the point that under Corning's scrutiny, glass can be readily made in shapes and for purposes that may never have occurred to you as possible with so hard, durable, and seemingly inflexible a material.

(And the fact that this item is made of a PYREX brand glass and stands up to the chemical action of the antiseptic solution should not be overlooked.)

From this bold mold you can induce that glass, economically mass produced by any one of a variety of processes, may hold the answer to some ticklish design and/or production problem of yours.

For nothing more than postage you might start finding out with a booklet called: "B-84—Manufacture and Design of Commercial Glassware." It tells about blowing, pressing, multiforming, sealing, assembling glass to metal, and other factors of interest to men of practical turn. Check the coupon for your copy.

Making light of it

Campers, world travelers and those deprived of electrical illumination have long turned to portable Coleman lanterns for light.

Pressurized gasoline is burned in a thorium mantle. These light sources give off with some 300 candle power, about what you get from a 300-watt bulb.

To achieve such an output, the mantle reaches and holds at about 3,000° F.

Problem: What kind of glass chimney will stand up near this internal heat, the differential ambient temperatures, and the rugged handling such a portable light is bound to get?

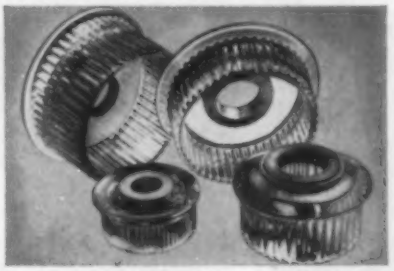
Answer: This is another example of where a PYREX brand glass solved a critical design problem, this time because of its low coefficient of expansion and high resistance to abrasion and physical shock.

For a brief rundown on the physical properties of PYREX brand glasses and other glasses, ask for our Bulletin B-83.

Godet (or how to spin a yarn)

Godet is the name given to a highly talented wheel used for spinning rayon yarn.

This intelligence by itself is neither startling nor revealing. And this picture tells you little other than that godet wheels are made of glass in dimensionally accurate intricate shapes.



Why we discourse on godet wheels (aside from the fact that we make them) lies in the somewhat unusual circumstances under which they operate.

First, viscose (cellulose solution in a mixture of carbon disulphide and sodium hydroxide) is extruded through a spinnerette into a solution of sulphuric acid. The coagulated yarn, comprised of as many as 800 delicate filaments, must then be pulled out of the acid, washed, and stretched.

Here's where the godet wheels take over. One, with a stream of hot wash solution running over it, pulls the yarn and snubs it. The other puts in the stretch.

And why glass for this chemical yarn spinning? First, there's the very important consideration of *dimensional stability*. This glass has it. Good thing, too, since any change in wheel size or shape, due to the affects of the acid, would change the wheel's peripheral velocity, and adversely affect the yarn stretch.

Moreover, the smooth finish of the glass wheels insures against fraying the fine filaments.

These wheels are also impervious to the corrosive action of both the acid and hot wash water.

And, glass is easily shaped to the complex fluted form required—in quantities, at reasonable prices.

Here's a spinning example of Corning custom engineering in glass—the right balance of the right characteristics—to do a very special type of job.

More examples are spelled out in "Glass and You." It's a good primer for learning a great deal about today's *engineered* glasses. Use the coupon. Free.

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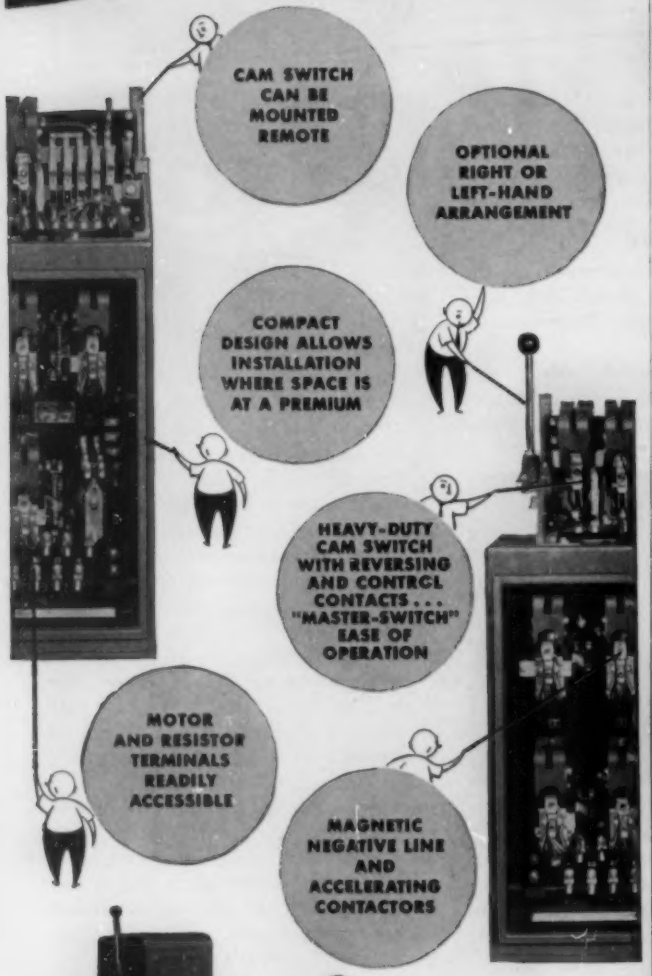
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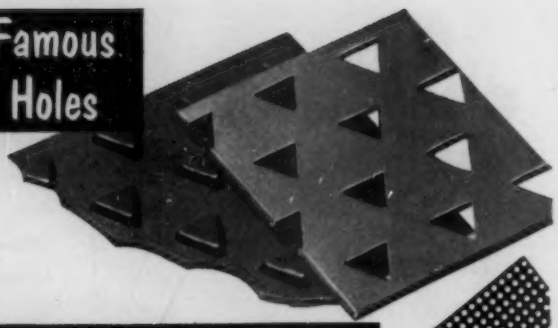
Famous Holes



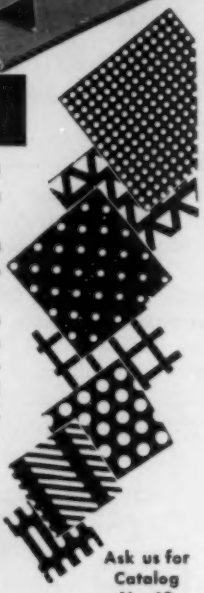
H & K Perforated

Triangular Holes have solved many difficult and decorative problems and are available in a number of different sizes.

Pictured here is a perforated steel sheet used as a mold for pressing its pattern in such materials as plastic and rubber.

Whatever your needs for perforated materials may be you are urged to consult our engineers whom you will find most helpful. We have thousands of standard perforations yet are prepared to build special tools for unusual requirements. Small orders can often be shipped from stock.

. . . and remember—if it can be perforated, H & K can perforate it.



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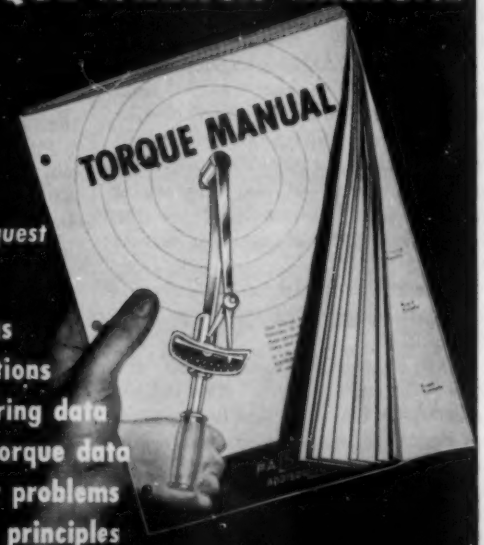

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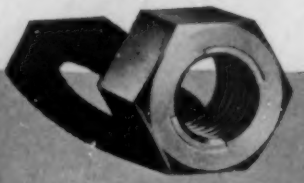

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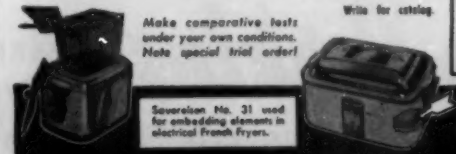

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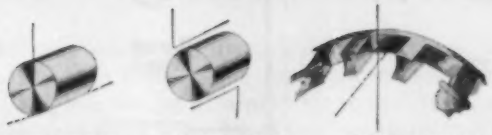

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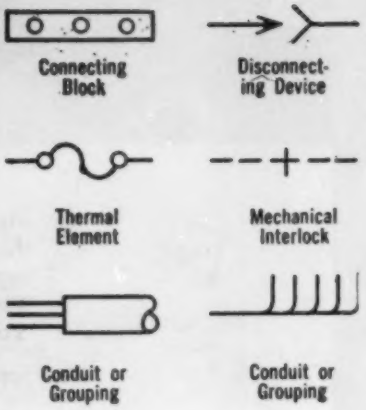

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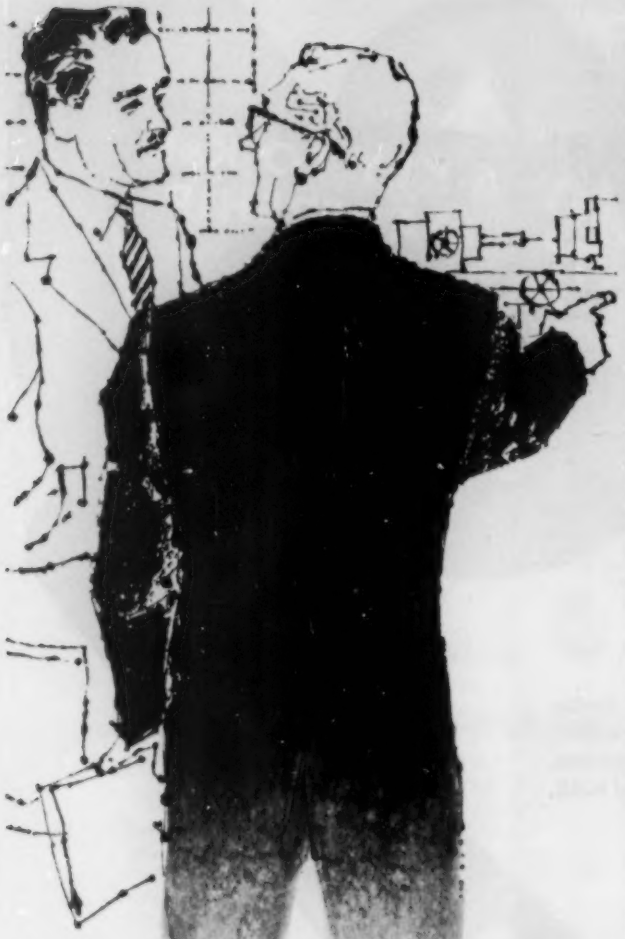

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CADDY Toggle Clamps are used on the FORD Cleveland Foundry core wash operation in the manufacturing of FORD and MERCURY engine castings.

The FORD Foundry turns out castings for both FORD Engine Plants in Cleveland and high production equipment is essential.

Prior to the adoption of the CADDY Toggle Clamps, FORD tested the clamps for 6 months. The key feature in the selection of CADDY was that they maintained uniform clamping pressure throughout the life of the clamp and developed no springing or wobble.

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CADDY TOGGLE CLAMPS

Erico Products, Inc.

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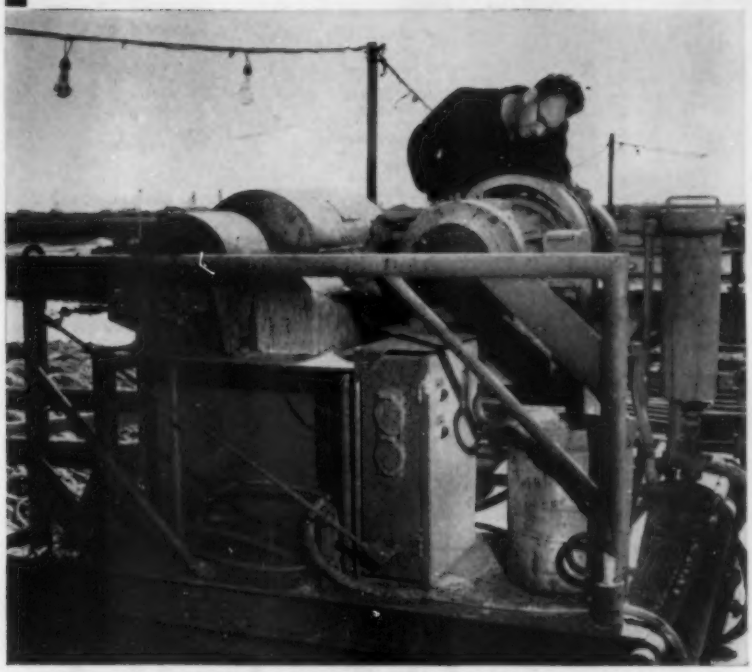
IN CANADA: ERICO INCORPORATED, 3871 Dundas St., West, Toronto 9, Ontario

Thanks to Gýrol Fluid Drive —

HOMCO's "Mud-Miser" electrical circuit is simplified



Unretouched photo shows HOMCO Mud-Miser installed near Rayne, La.

The "Mud-Miser" is a new application of the "Sharples" decanting-type centrifuge, developed by the Houston Oil Field Material Company, Inc., Houston, Texas. It is a compact unit, designed to separate and remove drilled solids from mud used in oil-drilling operations.

"Because of high starting torque, and to allow adjustable speed between 1800 rpm and 3200 rpm," states T. G. Bergey, HOMCO's division manager, "the normal electrical equipment would be bulky.

"The installation of a Gýrol Fluid Drive between the motor and the centrifuge eliminated the need for complicated electrical across-the-line starting equipment, and permitted simple speed adjustment.

"By allowing the 15-hp motor to reach approximately 90% of full speed before the load is automatically picked up, the starting-current load is reduced to the point where ordinary overload-protected starting equipment has proved adequate."

Type VS, Class-2, adjustable speed Gýrol Fluid Drive. Speed range: 5 to 1. Six sizes, 7½ to 800 hp; speeds to 1800 rpm.

Fluid Drive Only Way

"We feel that Gýrol Fluid Drive is the only means we can use for safe, sure, adjustable power transmission between prime mover and rotating members," concluded Mr. Bergey. Ask your nearest American Blower Branch Office for data on how Gýrol Fluid Drives can ease *your* power transmission problem.

Gýrol Fluid Drive is located between motor and centrifuge on Mud-Miser.

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Figure 4

24 page engineering data... Section

Figure 4 illustrates the mechanics involved in one method of determining experimentally the optimum tightening torque to be specified for a particular application of highly stressed bolts and nuts . . . Whenever possible this work should be done with production parts on the actual assembly, under actual assembly conditions, such as lubrication, temperature, etc., or with a test block . . . When such tests are impossible because bolt ends are inaccessible or for any other reason, a Torque Guide is helpful . . . All factors involved in the procedure to be followed and a Guide Chart, are included on pages 6, 7, 8 and 9 in the twenty-four page Engineering Data Section of our catalog . . . Requests for this literature will be handled promptly.

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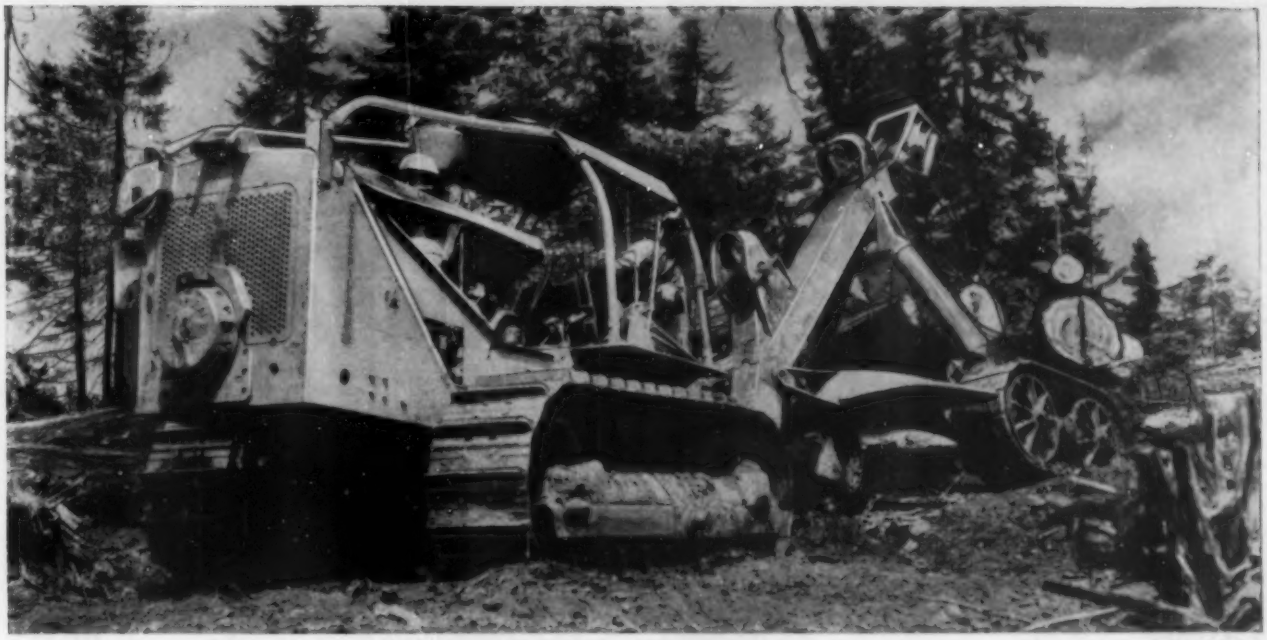

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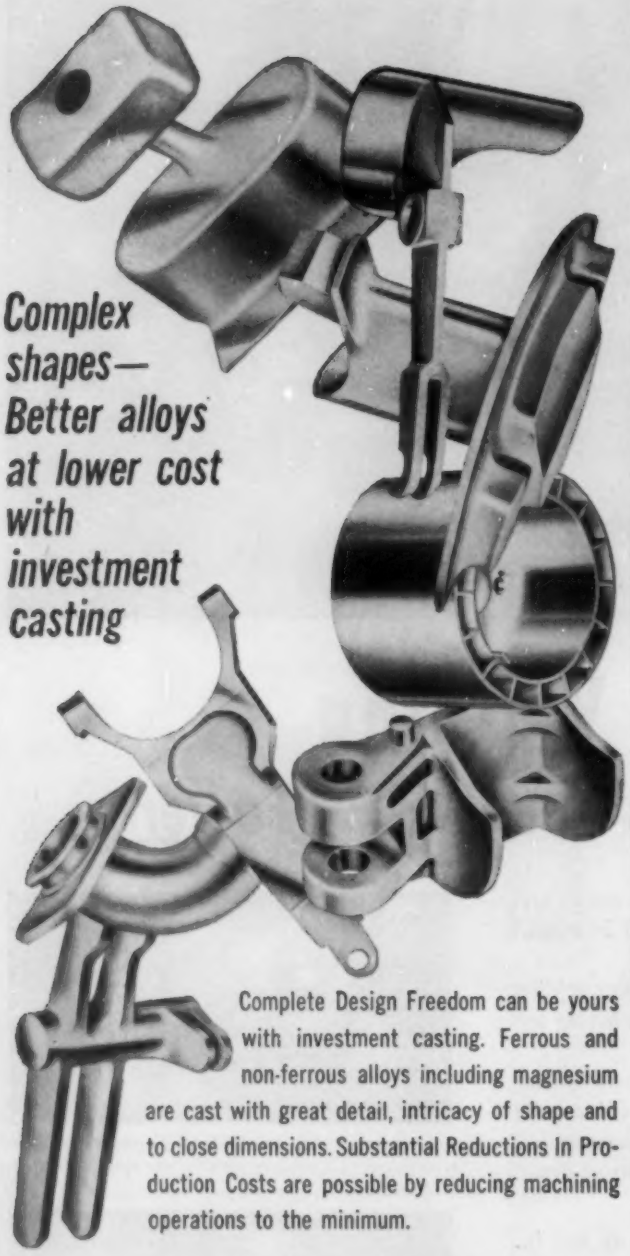

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It's easy to get the data you need on a wide variety of original equipment when you turn to either the product or advertisers' indexes of your 1955 Annual HANDBOOK of *Product Design*. Previous '54 and '53 issues can aid you, too, in specifying materials and components ranging from accelerometers to zinc-coated sheets. It will pay you also to use the specially enclosed postpaid cards for additional information, including manufacturers' catalogs and bulletins.

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Technical-ities

By John S. Davey

The Proper Loading of Bolts

The pre-load, or residual tension, in a tightened bolt means more to assembly strength than the actual strength of the bolt itself.

In a joint, a bolt torqued to its proper load level resists a maximum amount of external load without loosening. Designers can take advantage of this fact and assure better results, and at the same time, cut costs.

For example: One designer calculated that truck frames needed high strength bolts at least ½" in diameter. So he used ⅝". But on the assembly line, these were being torqued to 100 ft.-lbs. whereas they needed at least 200 ft.-lbs. for proper residual tension. The ½" bolt at 100 ft.-lbs. would actually have given the stronger assembly and at less cost.

In another case, the bucket on earth moving equipment was always coming loose. The design engineer kept increasing the size of the bolt up to 1¼", but to no avail. The impact wrench used was supplying far too little torque for this size. We suggested a return to the original ¾" bolt used, set up to 350 ft.-lbs. torque. It solved the problem.

In short, the more you stress a bolt within its elastic limit, the greater its ability to stay tight and make a strong assembly.

Symmetrical flow lines assure strong bolt heads

Photo of perfect cold worked blank after first upset.

Effect of improper forming is a poor head like this.

IN THE manufacture of bolts and cap screws, the first upset of metal is a vital one. It determines the flow lines in the bulb which will form the head. A symmetrical flow assures no laps and, therefore, no weak spots or cracks in the final upset of the head.

MACHINE OPERATOR'S SKILL VITAL

The upper photo shows a longitudinal section of a blank after the first upset and on its way to becoming an RB&W standard bolt. Note the even distribution of flow lines. This bulb will become a perfect head.

The lower photo shows what can happen with poor tools, inexperienced operators or without precision setup of the cold headers. Note how pronounced is the unbalanced flow pattern which resulted from a bulb with just a minute defect.

DEPENDABLE FASTENERS

Cap screws and bolts also get a bright smooth finish from the right kind of cold forming. But above all, they offer the designer low cost fasteners with sound internal structure. Standard RB&W fasteners can be loaded to their proper level —become a strong point in any assembly.

For help on your fastener problem, contact Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

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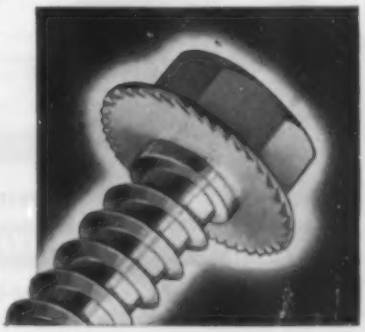
The continual heating and cooling caused loosening of handle screws on the flat irons of one manufacturer. Every type tried failed to stay tight until RB&W's unique Spin-Lock tapping screws were used. This solved the problem. Their hardened teeth lock into the surface, require more torque to loosen than to tighten. One piece fasteners, they speed assembly time.



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Elongation	800%
Compression Set 22 hrs. @ 158°F.	41%

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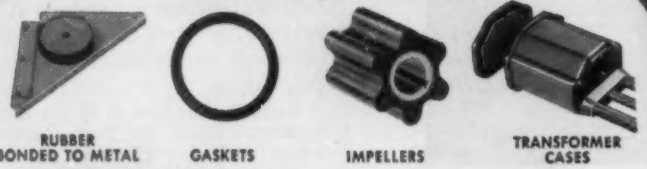

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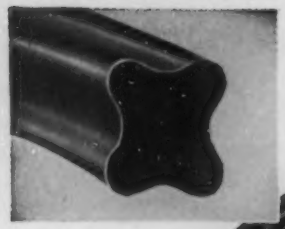

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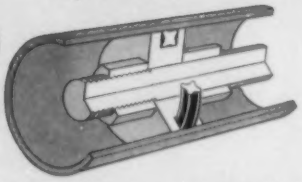

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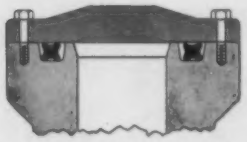

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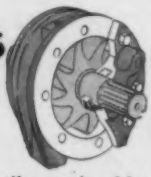

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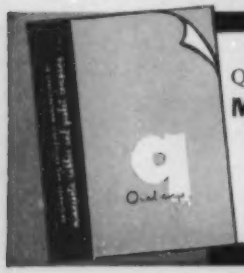

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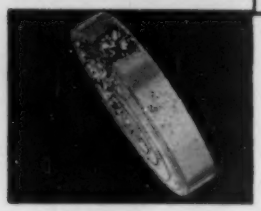

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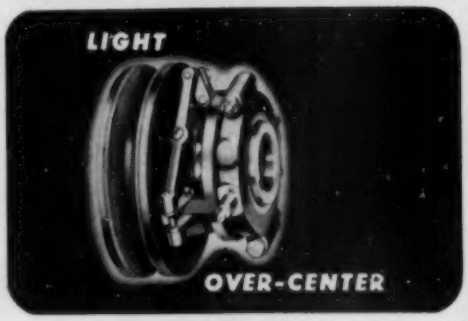

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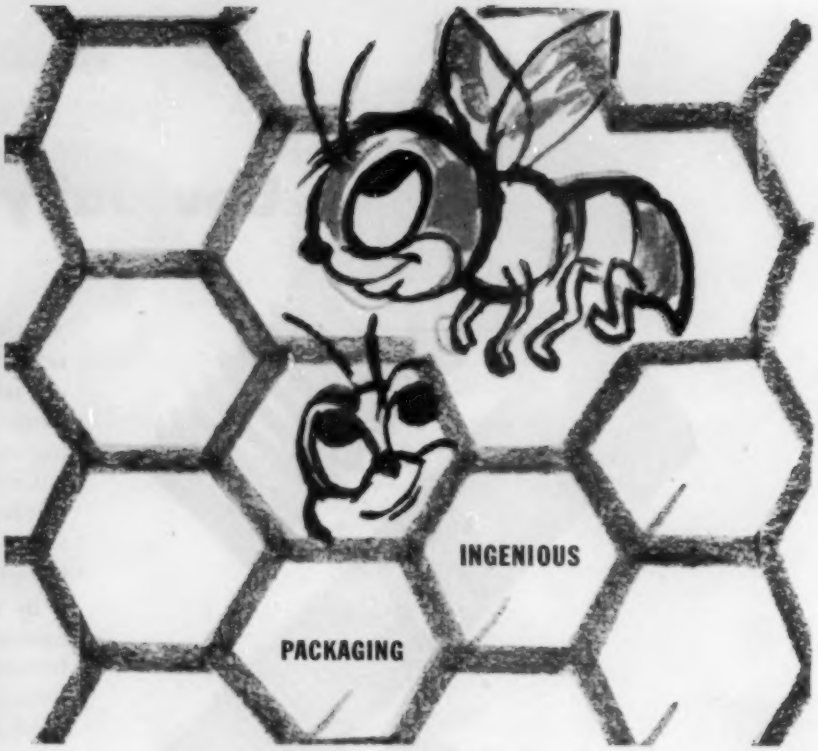

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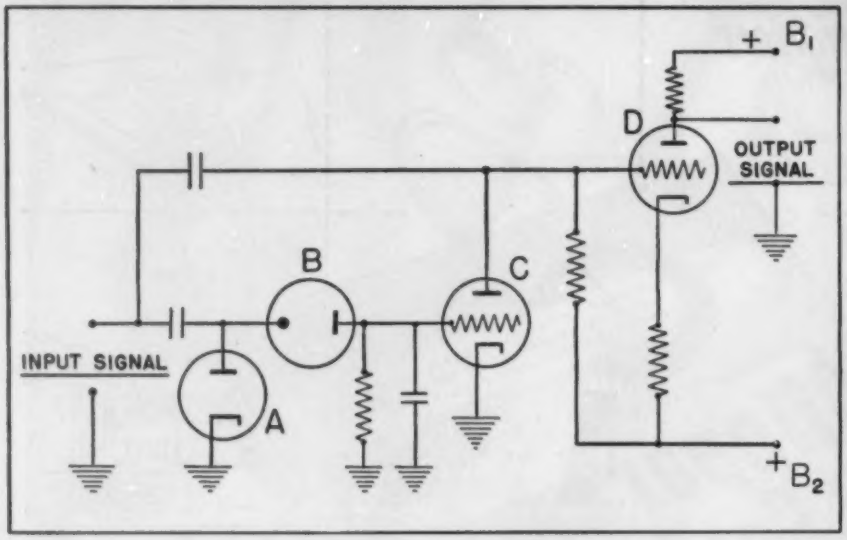

ELECTRONIC AMPLIFYING SWITCHING CIRCUIT

Both electronic switches and electronic amplifiers are used successfully in computer design. A very unusual circuit, patented by the Ford Instrument Company, combines positive switching action with amplification, and is particularly useful in such applications as multi-speed servomechanisms, in which several signals are to be applied selectively to operate the mechanism. When such a circuit is used, the inactive signals can be left connected without producing any noise whatever in the response to the active signal.

The key to the operation of this circuit is the voltage-doubler circuit consisting of diode A and gas tube B. When the signal voltage is below a specified level, gas tube B cannot fire and triode C draws a very large current, making the grid of tube D at almost ground potential. The cathode voltage of triode D is at a voltage B_2 above ground, thereby effectively cutting tube D off. If the signal voltage is above the specified level, gas tube B breaks down, cutting tube C off, thereby permitting tube D to conduct and actuate the servomechanism. The amplification produced by tube D, in addition to providing the required signal level at the servomechanism, contributes also to the effectiveness of the electronic switching, and the resultant circuit is more compact and has a higher parts economy than produced by the use of a separate switch and amplifier.

Electronic circuitry is but one of the many facets of Ford Instrument design and development. Ford Instrument engineers work every day with control systems, using mechanics, electronics, hydraulics, electro-mechanics, magnetics, and atomics. If you have a problem in automatic control, Ford Instrument stands ready to help you.

Visit our Booth #4 at MAN, THE ATOM AND THE FUTURE — Oct. 19-Nov. 3—Carnegie International Center, New York, N. Y.

75

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

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of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

Specializes in

Non-Metallic Gaskets

Since those pioneer days, we have been constantly developing new gasket materials and treatments for special services. We work with treated fibres, asbestos, synthetic rubber and a wide variety of beater mix materials. Tight seals economically produced, have been our objectives through the years.

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Worcester 6, Mass.

HOW IMPORTANT IS COST CONTROL?

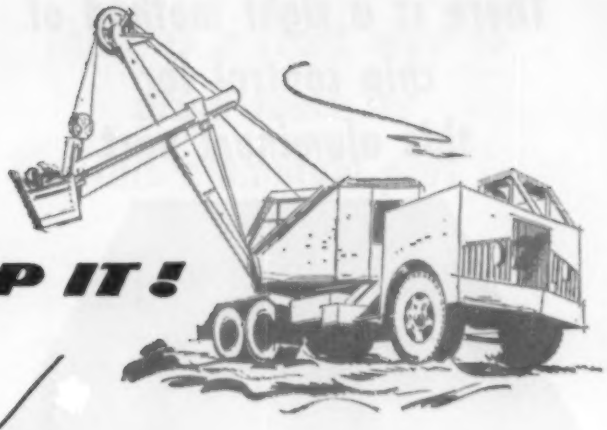
Some research engineers believe that the work of "costing" research problems is valuable time lost from more creative tasks. Experience shows, however, that well-planned systems of cost control can give research teams both a better understanding of design problems, and better methods for attacking these problems.

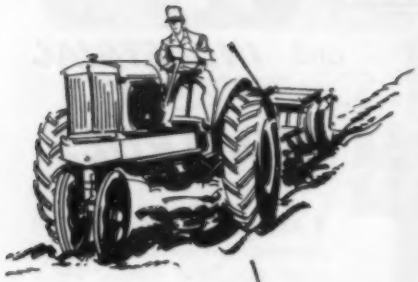
A detailed discussion, complete with charts and tables, of how you can organize such a program can be found under the General Engineering classification of your 1955 Annual HANDBOOK of Product Design. Hundreds of other informative and provocative articles also are contained in this issue (and in your '54 and '53 HANDBOOKS).

Product Engineering
McGraw-Hill Building,
New York 36, N. Y.

IF IT MOVES

WE CAN STOP IT!





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...for better control of heavy-duty industrial and farm equipment!

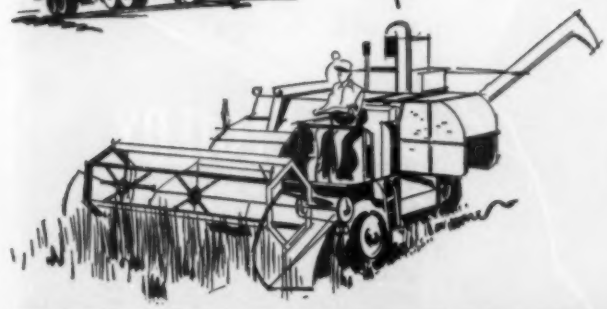
DLM—Revolutionary new all purpose brake

The versatile new DLM offers many improvements previously unavailable on most other present-day brakes. Its simple design utilizes only 8 parts . . . results in considerable savings in weight, installation and maintenance time, and actual material costs.

This new balanced-type brake insures constant, smooth performance in either direction of rotation, and is fully enclosed to protect against dust, dirt, and water penetration, reducing fire hazard . . . prolonging brake life . . . and improving on-the-job performance in all applications.

Exclusive features have greatly minimized service and inventory requirements, saving money for manufacturers and operators of trucks, harvesters, mixers, combines, winches, and many other types of heavy machinery . . . available in all sizes, for any type of work.

If somewhere in your business there is a special braking problem, big or small, we urge you to call on the ingenuity and vast knowledge of TDA engineers to solve it quickly, and at a minimum cost. An inquiry on your company letterhead will receive immediate attention. Just write Timken-Detroit Brake Division, Ashtabula, Ohio.



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Plants at:
Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

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TIMKEN-DETROIT BRAKE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ASHTABULA, OHIO
Accepted TDA Standard
TRADE MARK REGISTERED

There is a right method of chip control for this aluminum part

Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail this coupon today.

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Gentlemen:
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Company_____

Address_____

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

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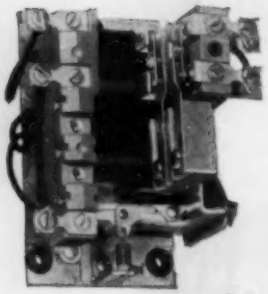

• Write for latest catalog covering the complete line of B/W Induction Relays, Relay Enclosures, Contactors and Starters, Multiple Pump Controls, Electrode Holders, Starter and Relay Combinations, Special Controls and Panels.

B/W CONTROLLER CORPORATION
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shows how Elgiloy can help save corrosion problems for you
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. . . another product backed by famous ELGIN quality!
It's a completely new spring material . . . fatigue and corrosion resistant beyond any other alloy available. Leading industries now use it to improve performance of springs, valves, instruments. Write today for the ELGILOY Booklet.
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ELGIN, ILLINOIS

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METAL PARTS . . .

● Standard or special ARco clips, clamps and other rubber insulated metal parts . . . these can add electrical and sound insulation; corrosion and abrasion resistance to cable, loom, tube, wire, rod and pipe products.

You can improve the utility and durability of your product by requesting expert ARco engineering counsel; sample rubber insulations on your standard parts, and quantity estimates. These ARco services are yours without obligation.

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ANYTHING CAN BE COVERED WITH RUBBER BY . . . ARco

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BLOWERS

Type F Blowers

Originally designed for cooling electronic tubes in transmitters, induction heaters and diathermy equipment, Heinze F 2 Blowers have become popular also for advertising displays and similar applications where a small current of air and quiet operation are required.

Characterized by low wattage, neat appearance and light weight. The shaded pole motor will not cause radio interference.

115v AC 60 cycles 15 watts
F2D (double) 20 CFM 3000 RPM (free air)
F2S (single) 10 CFM. 3000 RPM (free air)

Heinze Electric Co
685 Lawrence Street, LOWELL, MASS

There is a right way to grind tools for this aluminum part

Alcoa offers the answers here...

On many screw machine jobs there are operations which can be done in different ways, but, there is usually just one "best" way. To supplement your own experience, Alcoa offers users of Alcoa® Aluminum Screw Machine Stock a complete technical packet containing: calculators for feeds, speeds and properties; an engineering handbook on machining aluminum; a booklet of corrected tool diameter tables; case histories of savings; a conversion chart for alloy designations. The complete packet is free for the asking. Just fill out and mail coupon today.

ALUMINUM COMPANY OF AMERICA
865-K Alcoa Bldg., Mellon Square, Pittsburgh 19, Pa.
Gentlemen:
Please send your technical packet on Aluminum Screw Machine Stock to:

Name_____ Title_____

Company_____

Address_____

Your Guide to Aluminum Value

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA
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DESIGNERS

send us your telephone number

...it may mean a better future for you!

Because of increased emphasis on some of our long-range projects, we want to establish immediate contact with competent designers.

To those who qualify, we can offer a real opportunity to build solid, well-rewarded careers.

If you want a chance to grow, attractive wage rates, extra benefits, New England living — mail this coupon today!

Particularly important is your telephone number. We may want to call you at once to arrange for personal interviews or plant visits.

Mr. P. R. Smith
Dept. 7, Design Employment
Pratt & Whitney Aircraft
East Hartford 8, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

☐ Compressors	☐ Hydraulics	☐ Piping
☐ Turbines	☐ Gears	☐ Controls
☐ Structures	☐ Valves	☐ Test Equipment
☐ Afterburners and Related Equipment	☐ Heat Exchangers and Combustion Problems	☐ Test Rigs
☐ Aerodynamics	☐ Bearings	.....

Total years Mechanical Design experience .....

You can reach me at..... Most convenient (telephone number) hours for receiving calls are between.....and.....

NAME.....

ADDRESS .....

CITY.....STATE.....

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

World's foremost designer and builder of aircraft engines

IT TAKES TWO

DISPLAY ADVERTISING

- AROUSES INTEREST
- CREATES PREFERENCE

DIRECT MAIL

- GETS PERSONAL ATTENTION
- TRIGGERS ACTION

After your prospect has been convinced by DISPLAY ADVERTISING, he still must take one giant step. *He must act.* A personalized mailing piece direct to his desk, in conjunction with a display campaign, is a powerful action getter.

McGraw-Hill has a Direct Mail Division ready to serve you with over 150 specialized lists in the Industrial field.

To get your copy of our free INDUSTRIAL DIRECT MAIL CATALOGUE (1954) containing complete, detailed information about our services, fill in the coupon below and mail it to McGraw-Hill.

Do it now! The best advertising programs are planned well in advance.

Direct Mail Division,
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., N. Y. 36, N. Y.

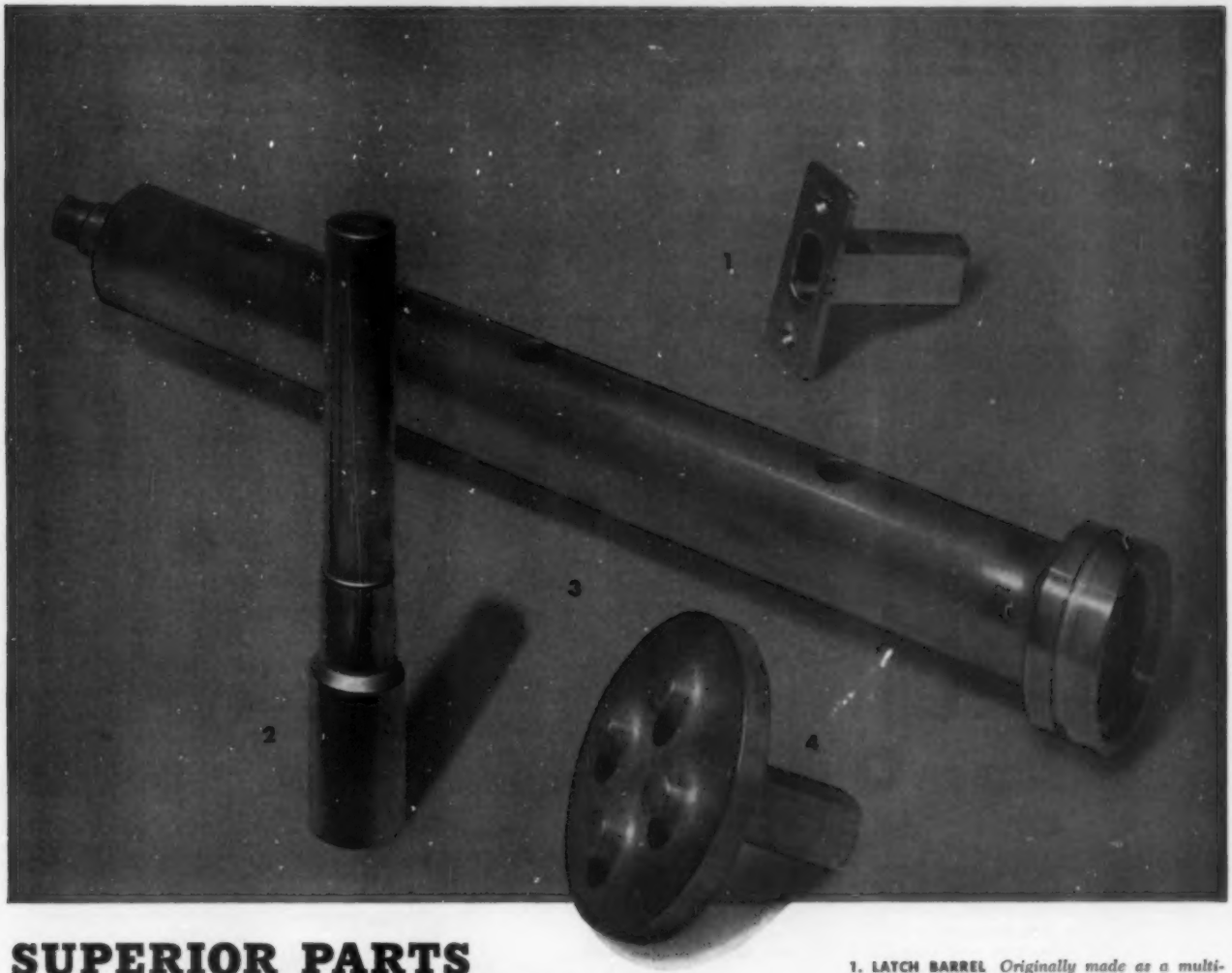
Please forward my free copy of the McGraw-Hill "Industrial Direct Mail Catalogue."

Name_____

Company_____

Address_____

City_____ State_____



SUPERIOR PARTS AT LOWER COST

with Hunter Douglas Aluminum Cold Forgings

Hunter Douglas One-Piece Aluminum Cold Forgings are important to every designer and manufacturer as a means of *simplifying design, reducing cost* or *producing stronger, better products!*

Hunter Douglas cold forgings and impact extrusions offer these advantages:

TUBULAR SHAPES, open or closed ends.

ZERO DRAFT in all hollow parts; reduces metal waste and machine time.

HIGH STRENGTHS obtainable with wide alloy selection.

DENSE METAL STRUCTURE "porosity-free," withstanding high pressures in hydraulic or pneumatic applications.

SMOOTH SURFACE FINISH (typically 63 rms. as forged).

CLOSE TOLERANCES meeting all commercial requirements.

ONE-PIECE CONSTRUCTION replaces multi-piece assemblies and costly fabrications.

The typical examples above show how designers have utilized Hunter Douglas Aluminum Cold Forgings to provide a better solution to production problems, with resulting design simplification and cost savings.

If your component requirements offer potential quantities of 10,000 or more per month, ask our engineering department for an analysis. A blueprint or sample part will facilitate our recommendation.

1. LATCH BARREL *Originally made as a multi-piece assembly of several stampings . . . now instantly produced as a one-piece Hunter Douglas Aluminum Impact Extrusion requiring no assembly time. Metal grain flow connects flange with tube in continuous, unbroken lines. Strength equalled the original latch barrel design.*

2. ORDNANCE COMPONENT *Formerly made as a three piece assembly with a critical gas leakage problem . . . solved with this one-piece Hunter Douglas Aluminum Alloy Cold Forging. Highly stressed, it withstands bursting pressures of 5500 psi without distortion . . . was actually produced with less metal than was formerly machined away as chips.*

3. HYDRAULIC PLUNGER TUBE *Originally a welded assembly of several steel parts, now cold-forged in one piece. Zero draft plus close tolerance eliminated all boring and turning operations. Machine time, assembly time and metal waste greatly reduced. Fine, porosity-free grain structure produced by cold forging, combined with the proper, heat-treatable aluminum alloy easily satisfies strength requirements of this highly stressed part.*

4. VALVE BODY *The pre-requisites of high strength and porosity-free metal structure made this part a "natural" for Hunter Douglas Aluminum Cold Forgings. Zero draft on all surfaces simplified chucking. The solid cold forging produced the long stem and four studs. Accuracy and detail produced by cold forging reduced subsequent machining to drilling and tapping.*

DESIGNERS:
If you want to know more about Hunter Douglas Aluminum Cold Forgings write on your company letterhead for this free 40 page book.

Hunter Douglas Corporation

HUNTER DOUGLAS CORPORATION, DEPT. PE-10 RIVERSIDE, CALIFORNIA TELEPHONE OVerland 3-3030

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $19.85 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.50 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to PRODUCT ENGINEERING, 330 W. 42nd St., N. Y. for November issue closing October 20th

MECHANICAL ENGINEERS IN ELECTRONICS ?

■ RCA's world leadership in electronics depends on creative mechanical engineering associated with electronic design and development. Boundaries are disappearing, in fact, between mechanical and electrical engineering responsibility. For ME's . . . this means greater challenge, added advancement opportunities.

■ Opportunities are open in these fields of mechanical design at RCA: radar systems, digital data handling devices, industrial electronic equipments, airborne fire control systems, missile guidance. Each calls for knowledge of structural design, high speed intricate mechanisms, shock, kinematics, vibration, thermodynamics.

■ You'll locate in Greater Philadelphia, with pleasant suburban and country living nearby. Broad, liberal RCA benefits, too.

Send complete resume of education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-13K, Radio Corporation of America
Camden 2, New Jersey

Radio Corporation of America

EXPERIENCED DESIGNERS-LAYOUT MEN

TO WORK AT
GENERAL MOTORS
NEW TECHNICAL CENTER

For Experimental Automotive Work in Transmissions, Engines & Chassis.

The work of this group is carried on in one of the nations most modern and complete research and development centers: located in suburbs of Detroit, Michigan. Exceptional opportunity for men looking to the future. Positions are permanent due to long-range plans. Outstanding company benefits.

State Full Particulars: Age, Experience, Salary Expected Etc. Send Resume to:

PERSONNEL DEPT.
ENGINEERING STAFF
GENERAL MOTORS CORPORATION
G. M. Technical Center **Detroit 2, Mich.**

CHIEF PRODUCT ENGINEER
$10,000 + — NO FEE

Should be experienced in overall project of research, design & development of machine tools, automation, special machines, packaging machinery. This is new project. Excellent future. All details handled efficiently and confidentially.

Contact — J. J. COOPER
O'SHEA EMPLOYMENT SYSTEM
"America's Largest"
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RAY EDWARDS & ASSOCIATES
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Midwest division of multiple plant manufacturer electronics and electro-mechanical devices rapidly expanding. Present technical director needs experienced line supervisor. Employer pays agency fee and relocation expense.

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Capable of general plant layout work and design for automatic control in connection with plant mechanization. Give experience and salary range with application. Location south.

P-7838, Product Engineering
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Experienced in Industrial Hydraulic Sales
Excellent Salaried Opportunity
Territories in Mid-West and New England

Address Replies:
SALES MANAGER—HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
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CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1111 Wilshire Blvd. (17)

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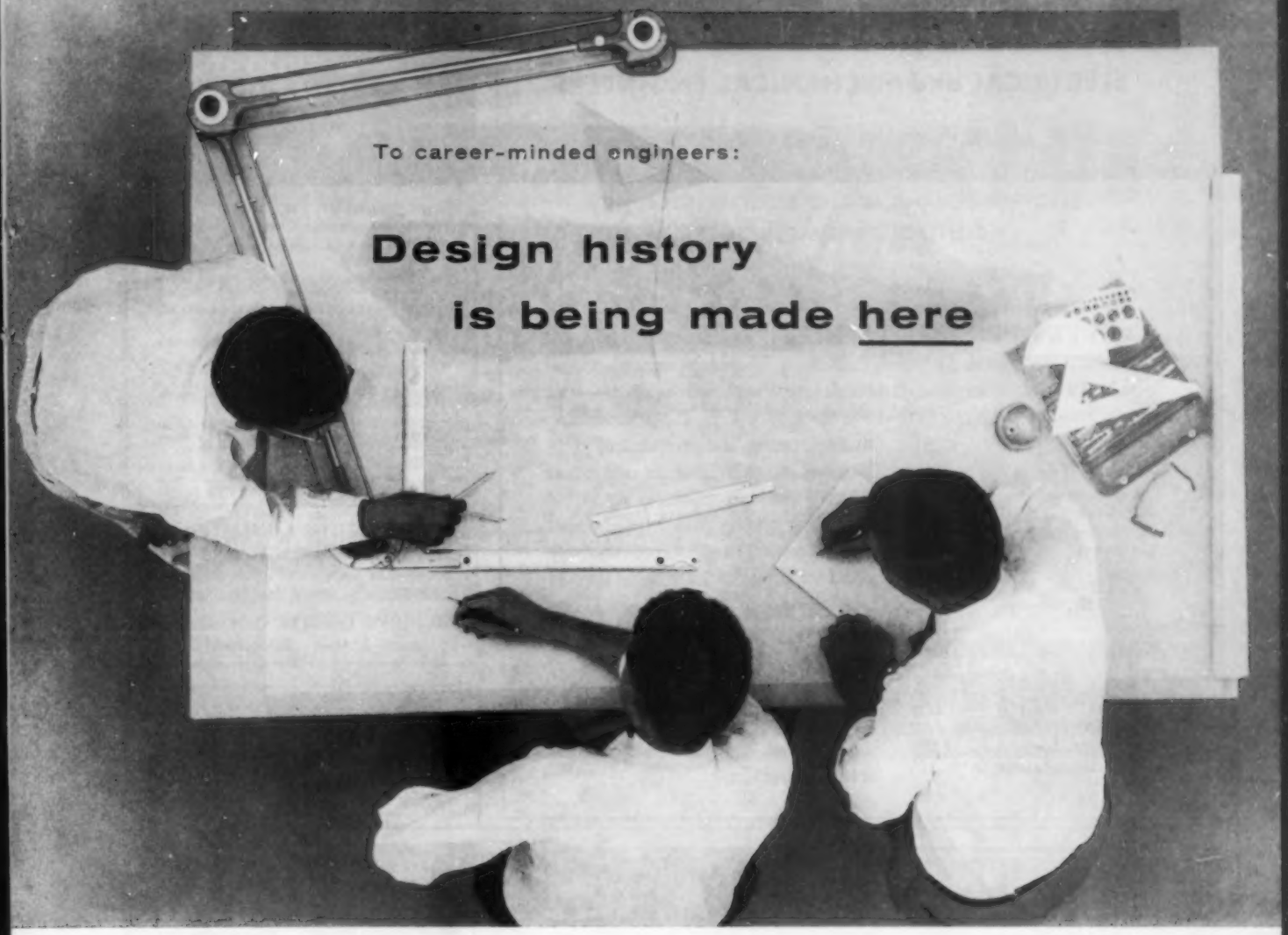
Wanted—(Strictly a sideline) mechanical engineer, steadily employed, residing within greater New York area, with home-workshop, to collaborate in developing new and novel ideas in the toy and game category. P-7704, Product Engineering.

Don't forget the

BOX NUMBER

When answering the classified advertisements in this magazine don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.



...at Lockheed in California

These design engineers are working on the F-104 air Superiority jet fighter.

They are participants in an expanding program that covers virtually every phase of Aeronautical Design. 46 major projects are in progress, including thirteen different models of aircraft already on assembly lines. Aircraft in development include the Electra, first U.S. turbo-prop airliner. Classified activities are equally significant.

There are sound reasons for these Design achievements:

Under Lockheed's Design philosophy, the Design Engineer makes major decisions on engineering problems. He works in an atmosphere of pronounced professional freedom. Original thinking, new ideas are welcomed and rewarded. Moreover, Lockheed emphasizes Design as a field that grows daily in importance.

In career terms, Lockheed's Design attitude and diversified program mean:

More scope for your ability with so many projects in motion; more opportunity for promotion because there are more upper echelon positions; more job security because Lockheed produces such a wide range of aircraft.

To engineers who lack aircraft experience:

Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering through its Engineering Transitional Program. Naturally, you receive full pay during the Transitional Program.

Lockheed offers engineers: Increased salary and overtime benefits; generous travel and moving allowances that enable you and your family to move to Lockheed at virtually no expense; a chance to enjoy life in San Fernando Valley.

A report on "Maintenance Design of High Speed Aircraft" taken from one of Lockheed's monthly engineering and manufacturing forums is available to interested engineers. Address requests to Forum Chairman J. F. McDonald.

Lockheed's expanding Design program has created positions at all levels in mechanical, electrical, hydraulic, power plant, controls and structures fields. A brochure describing life and work at Lockheed will be sent you upon request. Address E. W. Des Lauriers, Dept. DH-30-10

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AIRCRAFT CORPORATION • CALIFORNIA DIVISION

BURBANK **CALIFORNIA**

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AC AND DC SUBFRACTIONAL MOTORS
SERVOMECHANISMS
ELECTROMECHANICAL AND ELECTROHYDRAULIC
CONTROLS AND ACTUATORS

We are now staffing the new Electronics Laboratory of our Aeronautical Division in Anaheim, California. The selection of associates is based on consideration of their demonstrated abilities and interests in connection with our long-range laboratory plans. Careful attention to engineering and operational planning and to the selection of critical control problems assures opportunities for continuous professional development. The efforts of a relatively small but select staff are being applied on projects requiring engineering ingenuity essential to advancing the art of control in the aeronautical field.

Mr. Controls

Positions are available at all levels of laboratory work. Please direct inquiries to Vernon Vogel, Electronics Laboratory Director.

Aeronautical Division
Robertshaw-Fulton
CONTROLS COMPANY
SANTA ANA FREEWAY AT EUCLID AVENUE
ANAHEIM, CALIFORNIA

PERSONNEL MANAGERS

LOOKING FOR ENGINEERS... ...TECHNICIANS?

Write for free copy of

"RESERVOIR OF ENGINEERS AND TECHNICAL MEN"

The engineers and technicians you want to reach are gathered in convenient, compact groups—as this 12-page booklet points out.

It keys the job titles these men hold to the McGraw-Hill publications they read for on-the-job information. It explains how you can make contact . . . channel, concentrate your employment advertising to just the men with the job qualifications you want . . . without wasting advertising money for higher-priced space in publications with general circulation, in which you pay for perhaps 999 unqualified readers for every 1 who may meet your job requirements.

Write for your free copy to: Classified Advertising Division

McGRAW-HILL PUBLISHING COMPANY, INC.
330 W. 42ND ST. NEW YORK 36, N. Y.

SEARCHLIGHT SECTION
(Classified Advertising)

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$1.50 a line, minimum 3 lines.

To figure advance payment count 5 average words as a line.

Box Numbers—Care of publication count as one line.

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DISPLAYED RATE

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Patented or unpatented products in any field. No fees. Write for Brochure L-1.

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10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order

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Noroton Heights 3 Offices Darien, Connecticut

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ELECTRO-MECHANICAL DESIGN DEVELOPMENT SERVICE
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Farnsworth IT&T has a future for ELECTRONIC ENGINEERS

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Research, systems analysis, development, and design in guidance and control systems, systems component equipment, and systems operational test equipment.

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Research, development, and design in Guided Missile operational test equipment systems and systems component equipment.

MICROWAVES

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Study, analysis, development, and design in highly advanced radar techniques, and electronic countermeasures.

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Career-minded men with several years specialized experience, and preferably with advanced degrees, are invited to join our rapidly expanding programs in industrial and military electronics.

Address inquiries to:

Technical Employment Manager

FARNSWORTH ELECTRONICS CO.,
Fort Wayne, Indiana
A division of International Telephone and Telegraph Corp.

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an experienced man capable of supervising and operating automatic high speed-sanitary can lines. Excellent opportunity for a good man to assure himself of a permanent job with a good future. Salary open. Call or write to:

ATLAS CAN CORPORATION
50th St. & 1st Ave., B'klyn 32, N. Y.
STerling 8-1040

PRODUCT DESIGN ENGINEER

Desire to leave the crowded city? Opportunity exists in pleasant community of 30,000 for a product design engineer experienced in design of mechanical products. Must have B.S. degree in engineering and be under 40 years of age. Salary commensurate with training and experience. A major portion of Ansul Chemical Company's business is derived from mechanical products.

Write Personnel Manager
Ansul Chemical Company
Marinette Wisconsin

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DESIGNERS • DRAFTSMEN
How do you Measure success?
Some measure success only by money; others by the enjoyment they get out of their work. But the true measure of success is a combination of both *plus* the knowledge that your efforts are recognized and appreciated.
Melpar engineers find diversity and opportunity for professional growth; they enjoy being part of a highly creative staff without losing their individuality; and they benefit from Melpar's completely integrated facilities for system responsibility from design concept through production.
To learn how Melpar measures up to your own standards send complete resume to
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• Automation
• Microwave Technique
• UHF, VHF or SHF Receivers
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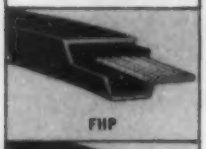
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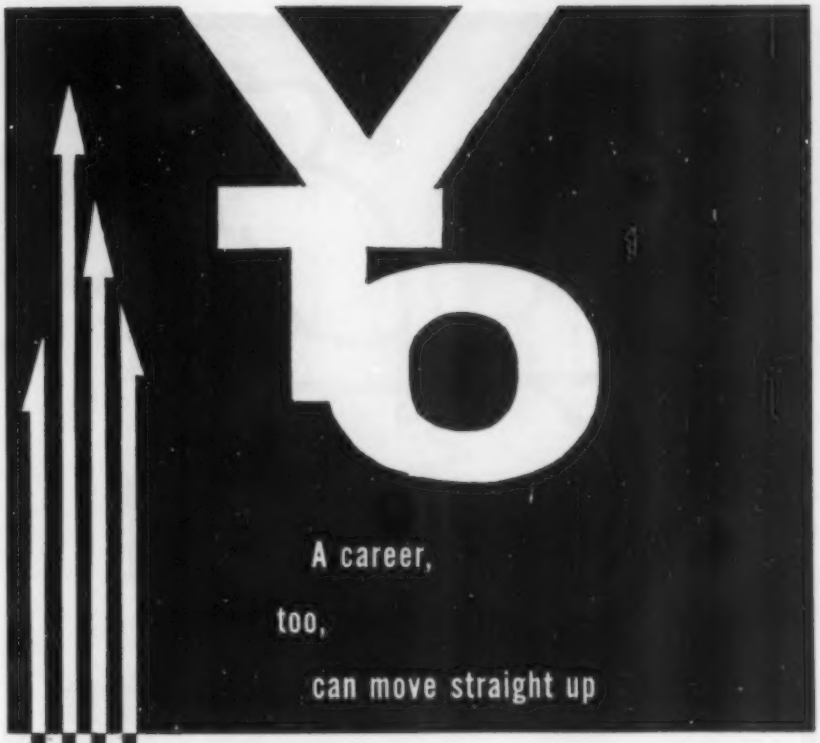

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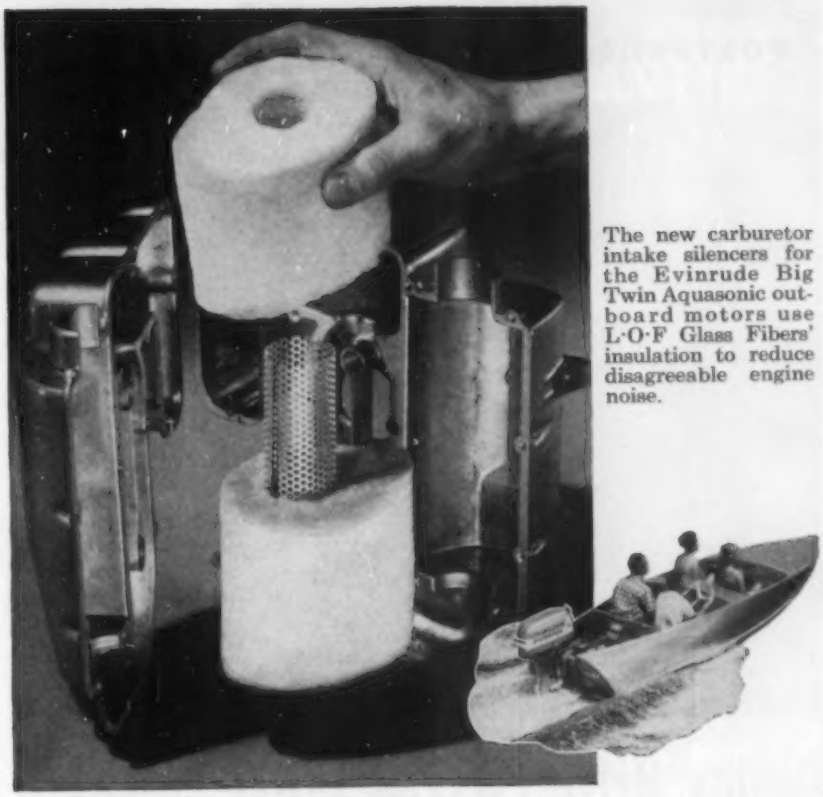

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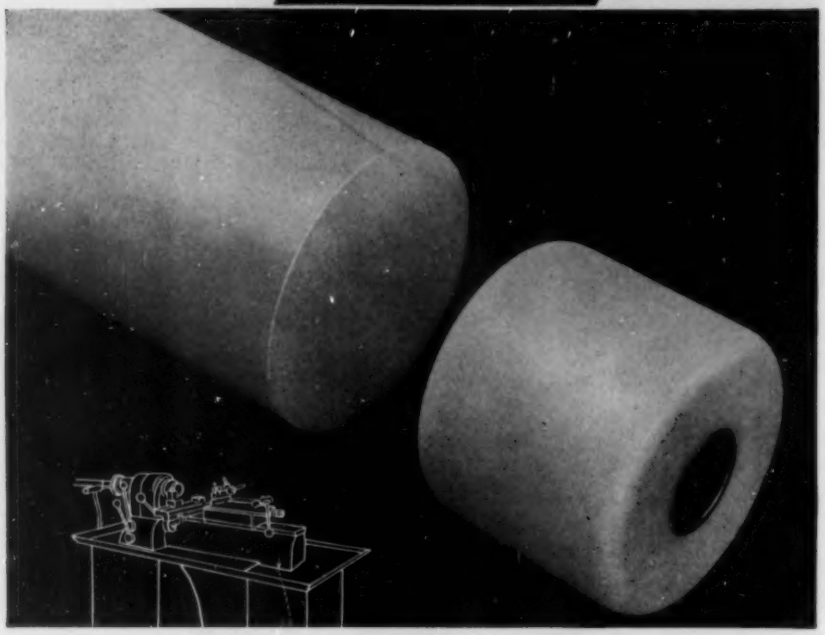

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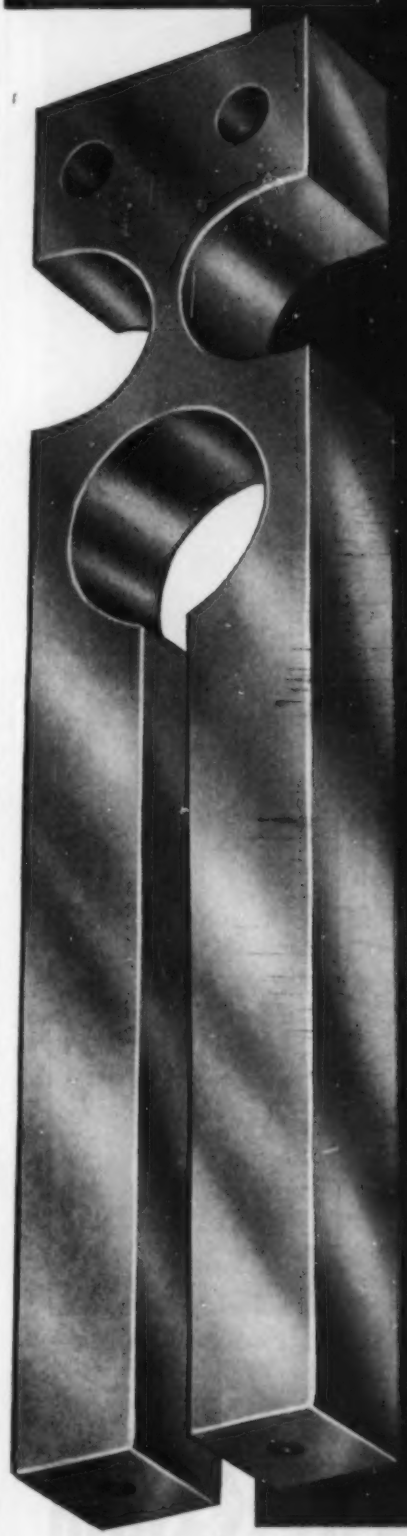

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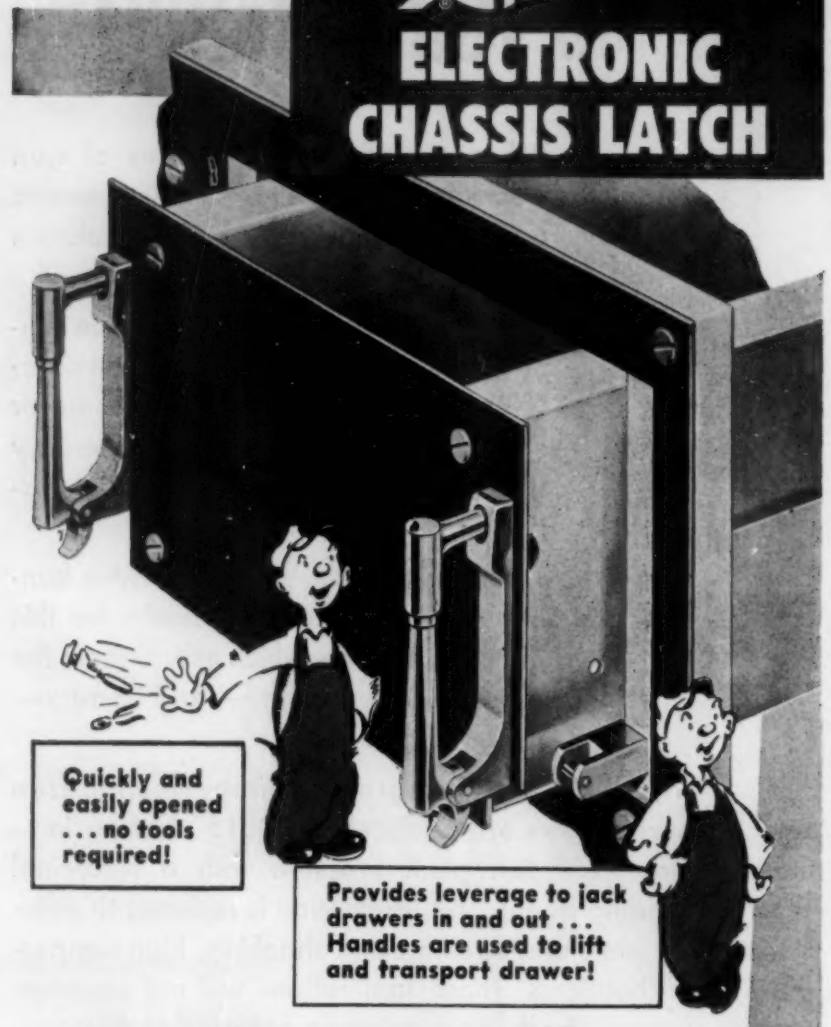
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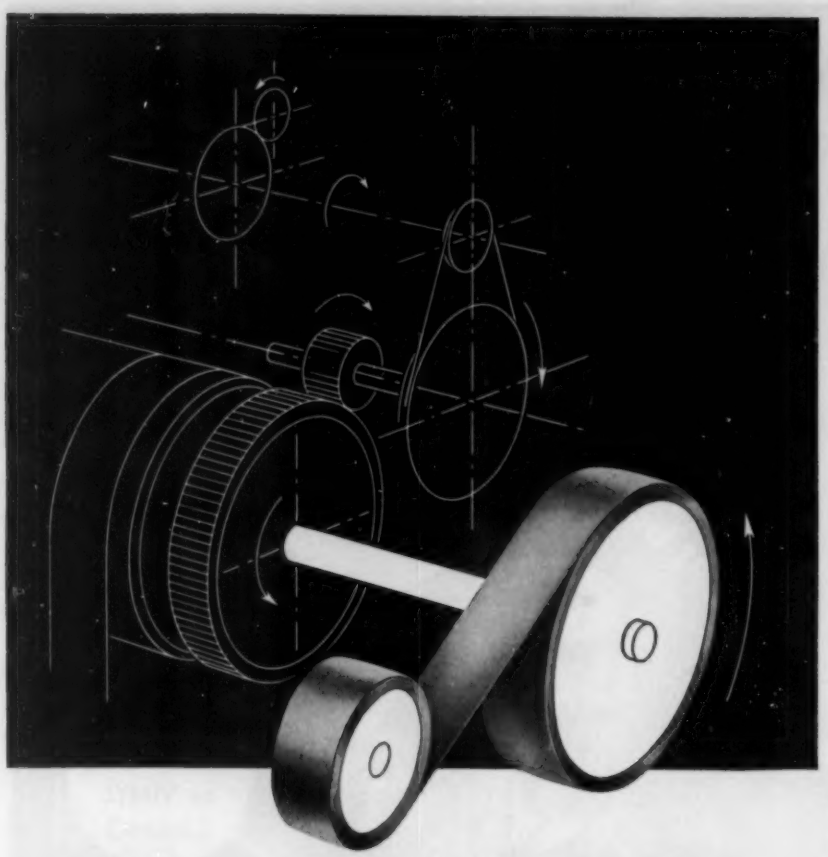

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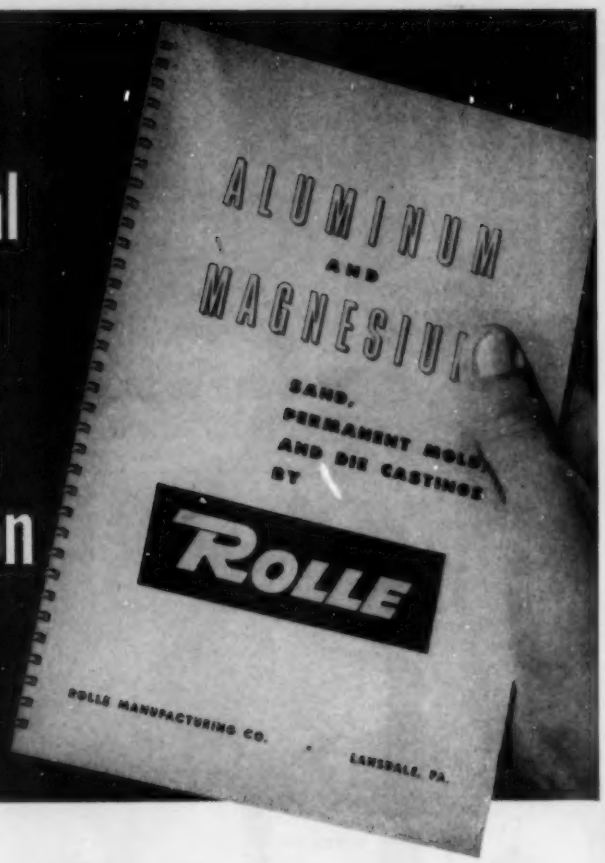

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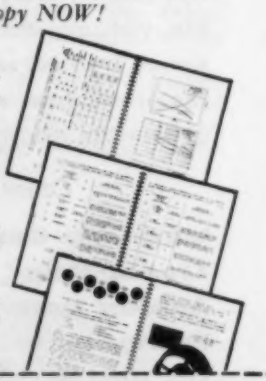

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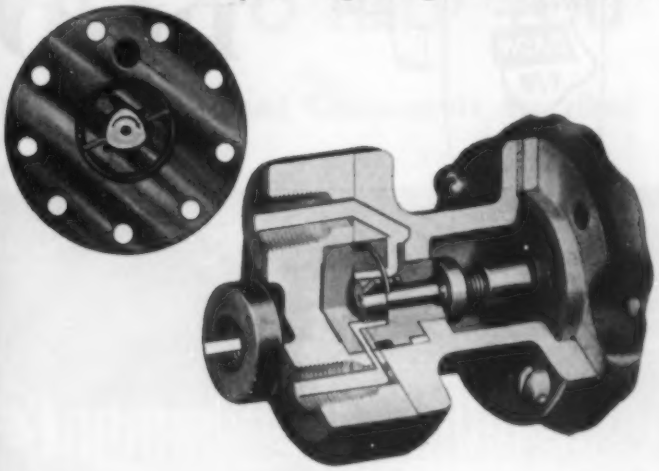

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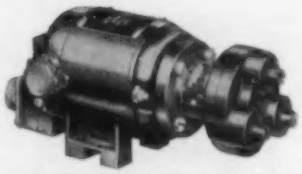

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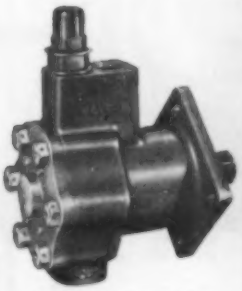

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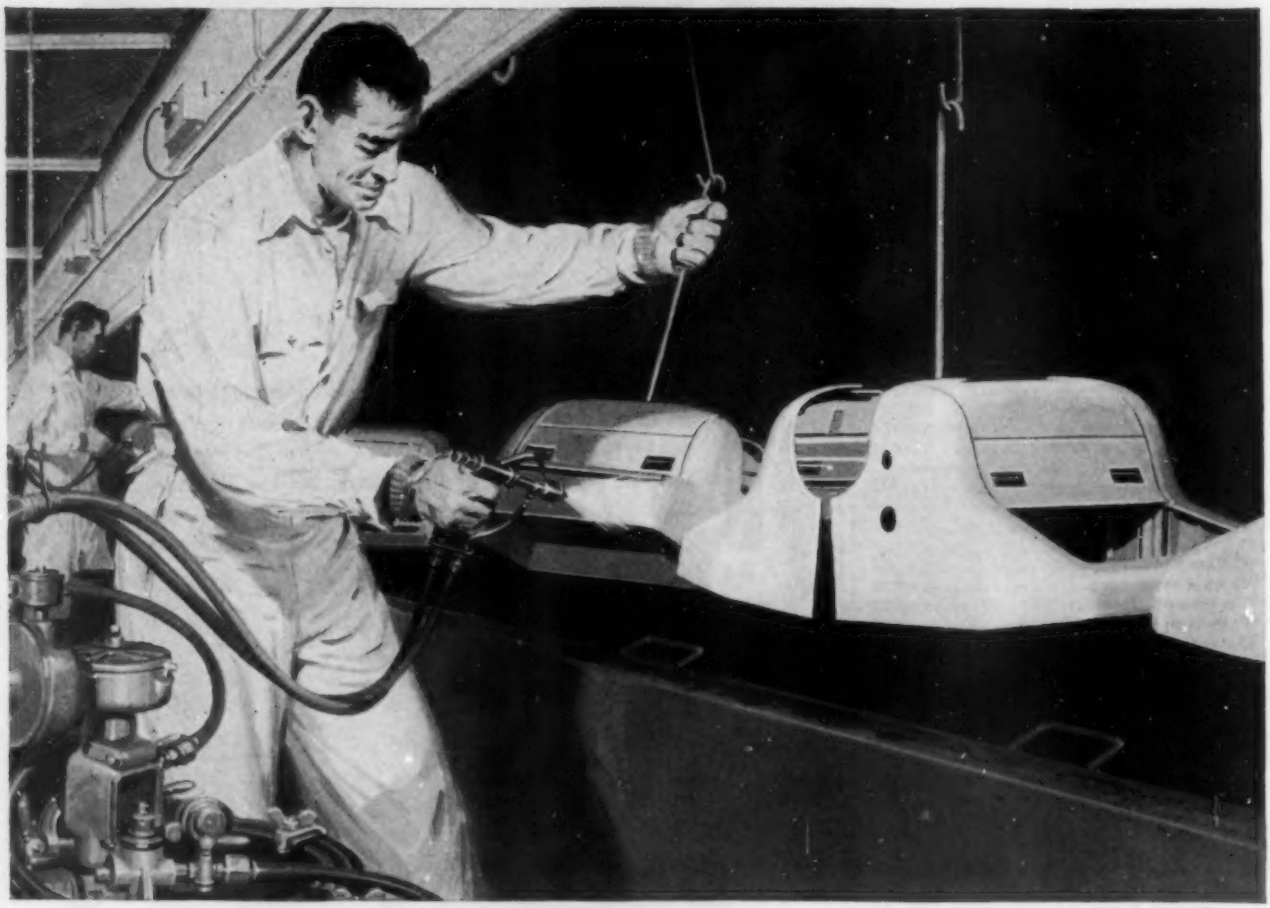

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81—Reports Shaft Positions
82—Perforated Tape Reader
83—Eight-Position Rotary Switch
84—Terminal Blocks
85—Bladed Power Connectors
86—Connectors for Leakproof Service
87—Miniature Axial Blower
88—Reinforced Plastic Cable Clamps
89—Silicon Power Rectifier
90—Miniature Power Resistor
91—Wiring Diagrams on Adhesive Tape
92—Rigid Plastic Wiring Ducts
93—Oil-Tight Push Button Enclosures
94—Small Electrical Thermostat
95—Silicon Solar Battery
96—Hydraulic Power Pump
97—Indicates Pipe Line Flow
98—Restrictor Valves For 3000 Psi
99—Heavy-Duty Cam Valve
100—Forged Steel, Inside-Screw Valve
101—Automatic Hydraulic Valve
102—All Brass Valve
103—Hydraulic Shut-Off Valve
104—Full-Port Solenoid Valve
105—Hydraulic Servo Valves
106—Needle Valves for Small Flows
107—Hydraulic Cylinders
108—Oil-Hydraulic Power Units
109—Ball Joints for Piping
110—Thin-Section Metal Stampings
111—Plastic Coated Steel Tape
112—Leaded Round Steel Bars
113—Tracks For Sliding Panels
114—Epoxy Finish For Metals
115—Cold Punching Laminate
116—Felt Machinery Mounts
117—Drafting Machines
118—General Purpose Drafting Machine
119—Lamp for Drawing Board
120—Template for Squares and Diagonals
121—Template for Drawing Circles
122—Transistor Power Supply
123—Mechanical Sound Detector
124—Measures Speed At a Distance
125—Electronic Flaw Detector
126—Mobile Power Supply
127—Digital Voltmeter

NEW BULLETINS . . . listed below are described on pages 282 to 289. Circle key number for your copy.

128—Stainless Tubing, Tubular Parts
129—Wire Rope Assemblies
130—Speed Control Packages
131—Vacuum Melted Alloys
132—Epoxy Adhesive
133—Lithium Industrial Greases
134—Magnesia-Insulated Conductors
135—General Purpose Power Supply
136—Totally Enclosed Motors
137—Magnetic Disc Brakes
138—Brazing Preforms
139—Posture Chairs
140—Photoelectric Controls
141—Wheels
142—Air Cylinders
143—Heat Absorption of Steel
144—Hot-Formed Nuts
145—Constant-Force Springs
146—Specialty Steels
147—Electrical Switches
148—Pneumatic Equipment
149—Solenoid Brakes
150—Enclosed Switches
151—Hydraulic Cylinders
152—Filter-Lubricators
153—Oil-Hydraulic Pumps, Controls
154—Speed-Sensitive Switches
155—Air Cylinders and Devices
156—Metal Spinning
157—Pressure Generators
158—Tool Steels
159—General Purpose D-c Power Supply
160—Silicone Rubber
161—Industrial Fibers
162—Arc-Cast Molybdenum
163—Ball Bearing Sprocket Idler

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164—Shaped Tubing
165—Chromium Plating
166—Ball Screws
167—Cold Forming
168—Plug-in Components
169—Bellows and Metal Hose
170—Miniature Bearings
171—Aluminum Alloys
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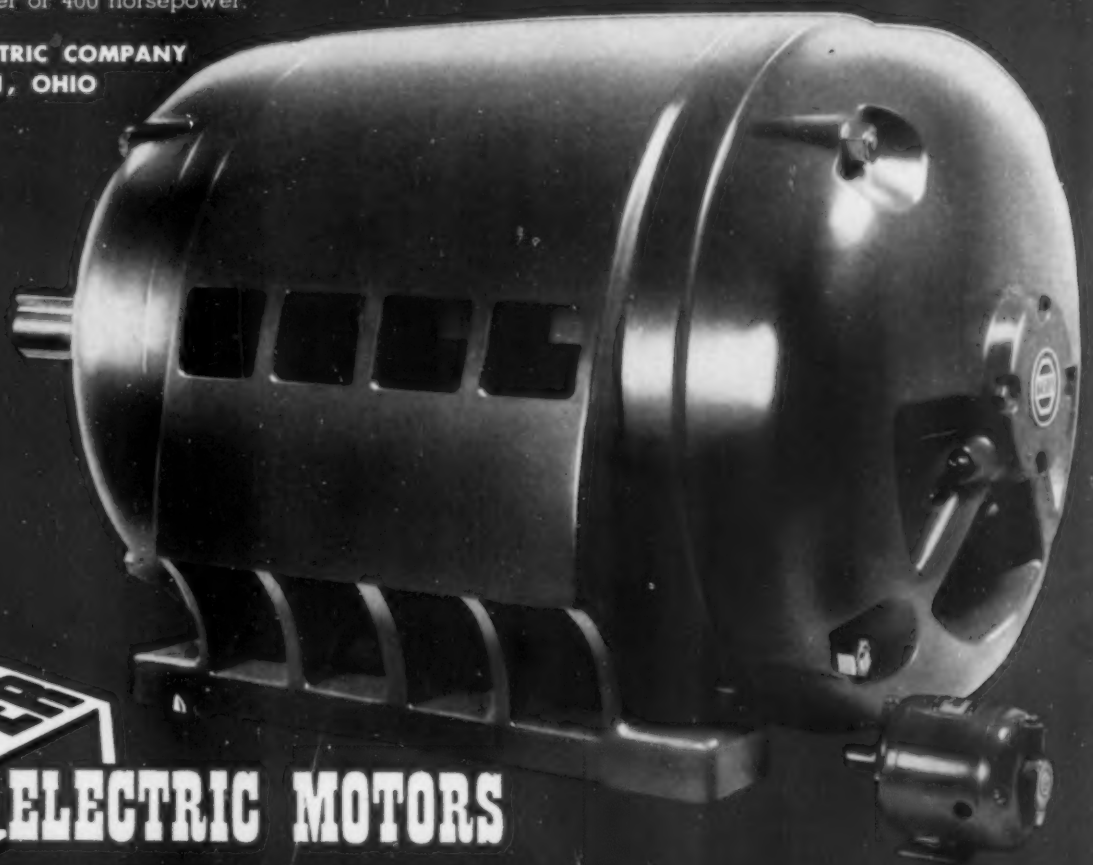

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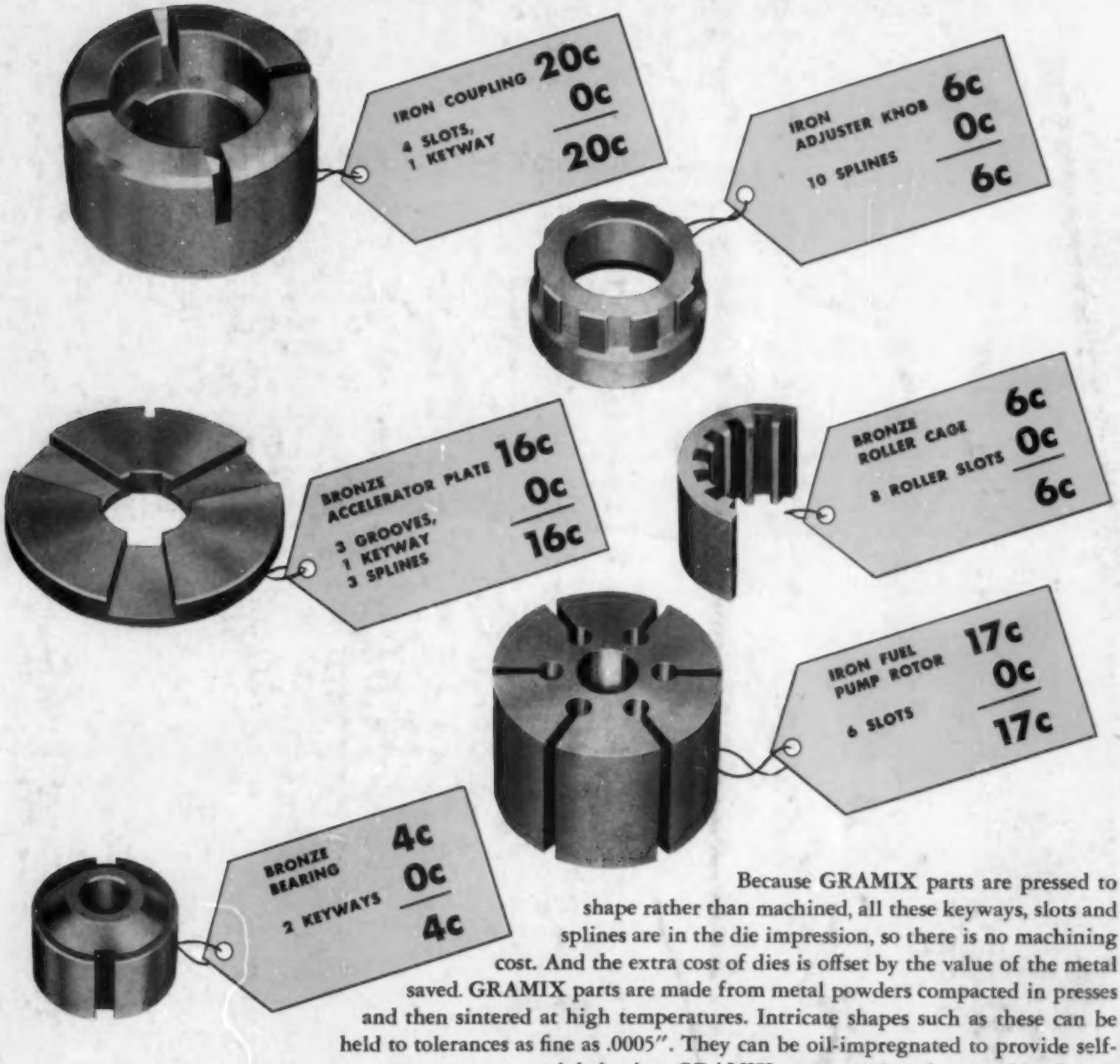
are practically FREE!



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